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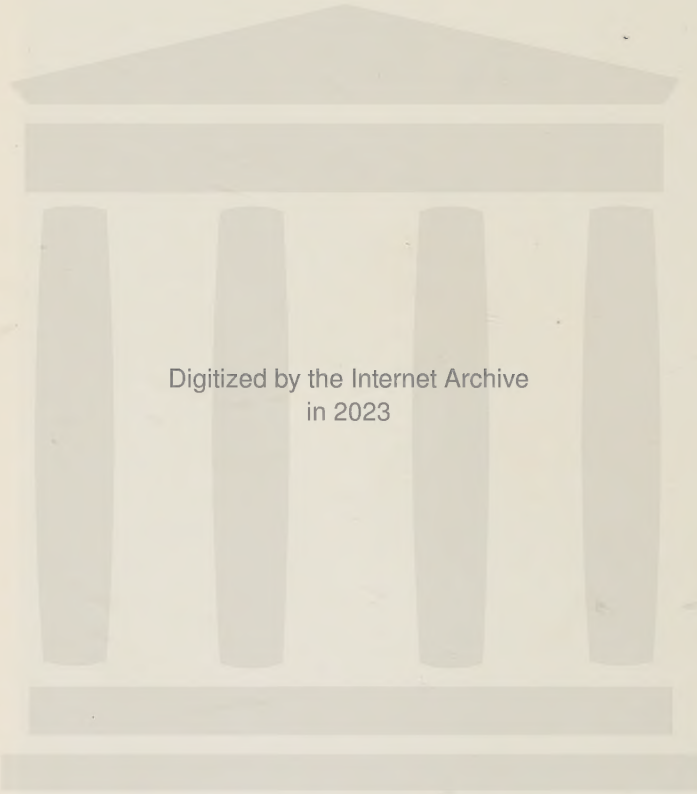
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THE ENGINEER'S PART IN COMMUNITY LIFE

PRESIDENTIAL ADDRESS by CARROLL A. FARWELL*

Boston Society of Civil Engineers, March 20, 1946

It is entirely possible that there is nothing new in what I am about to say. Certainly parts of it have been said better by others. Nevertheless its importance makes it desirable to bring the subject forward frequently and in varying phraseology.

While community life includes other phases—social, religious, etc.—a very important one is the public or governmental phase and this is the one on which I wish to concentrate.

Many, perhaps most, of us are made unhappy by situations or occurrences which we observe, or are told about, in the carrying on of the business of government, be it town, city, state, or federal. We often feel that we could perform much more efficiently and that engineers should be given a larger part in public affairs. I have used the expression “given a larger part” advisedly; we do not in general feel that we should *take* a larger part, but that instead, our help should be solicited. Probably this is due to the basic idea of the professional man—the architect, the doctor, the lawyer, as well as the engineer—that his client or patient should come to him. No doctor or lawyer would wish to be classed as an “ambulance chaser.”

Engineers as a rule take pride in being members of their profession. They like to feel that its code of ethics is of high grade and that there is more to life than the acquiring of money. Satisfaction in a job well done often outweighs a low return. This frame of

*Partner, Fay, Spofford & Thorndike, 11 Beacon St., Boston, Mass.

mind tends to make an engineer take a minimum of interest in the business arrangements, including therein the business of government.

This lack of interest on the part of the citizen engineer may be rudely shaken when he gets his property tax bill, figures his income taxes, observes inefficiency in town or city operations, hears discharged Army or Navy officers describe military procedures, or notes the number of persons who appear to use unemployment compensation as a "racket." He feels that if engineers had a larger influence in governmental affairs, there would be an improvement. However, he does not care to get into any political controversies and after a certain amount of "griping," does nothing about it.

I am not contending that there are not many engineers who have taken part in the administrative functions of government; in fact, at least one of our members is serving as Selectman in his home town, and others are on city committees, but I submit that most of us avoid any such activities.

It has been stated that during the recent United Nations Conference at San Francisco no scientific or engineering groups were among the more than forty organizations selected to aid the U. S. Government. Does this seem right?

It is frequently felt that the general public does not appreciate the engineer and therefore does not elect him to office or seek his help. If this is true, and it may well be, whose fault is it? I am inclined to feel that it is largely the fault of us engineers and that it is up to us to find a way of remedying the situation.

Some may say that they have no desire to take a greater part in public affairs and if they feel that the government is well run at present, there is no reason why they should seek a part. If, however, a man feels that conditions are continually getting worse, that in time our country will be a less pleasant place in which to live and that his children should have at least as good a chance as he had, then he should endeavor to do something about it.

There are many functions of government in which the engineer can, with all due modesty, claim to be particularly well qualified to serve and in such fields he should be insistent that he be heard. Those of us who are in private practice feel that we would not be giving a client proper service if we did not object to actions on his part which we felt were detrimental to a project on which we were engaged. Are we any less blameworthy if we deliberately overlook

government actions coming within our sphere which we feel are detrimental to efficient government?

In general it seems fair to state that the engineer is as industrious as other members of the community. He probably puts more time into his business than the average lawyer, or businessman—he may, or may not, spend more time in his garden, but I have the distinct impression that he spends less time in town affairs, assuming that he is a suburbanite. He may feel that his interest in town affairs would not be appreciated but, if so, this is quite probably his own fault and if he brings good judgment, tact, and ability to the affairs of his community, his interest will in time be appreciated.

Anyone who is required to concentrate on details tends to lose sight of the broader aspects and the engineer's nose is often held close to the grindstone for too long a time. However, the engineer's training should make him insistent on securing the basic facts without which he cannot arrive at logical conclusions. While many young engineers do not appreciate that engineering is not pure science and therefore that time and cost must be given weight, most are disabused of this in a short time. I well remember when I was a chief-of-party on preliminary canal location and suggested to my boss that I could save considerable excavation by further trial locations of a certain section of canal. He told me to leave it alone, the two weeks' time I would need would more than outweigh any yardage I could save.

The old-time definition of an engineer as one who could do for one dollar what any fool could do for two is still valid and such a man's help should be of value in any business.

We must admit, however, that in the minds of some self-styled practical people the engineers are often thought to be theorists and dreamers, perhaps because we try to take a long-range view. We must be careful in dealings with the average citizen to stick close to the dollars and cents basis which, however, does not mean that we should think only of the present with no regard for the future.

If it is agreed that engineers do not in general have a proper part in government and if it is agreed that they can help to a greater extent than they are accustomed to, what can and should engineers do about it?

Quite possibly the older engineers cannot change their attitude of disinterest although this would not be universally true. However, in general, improvement must come through the younger men. The technical schools are constantly striving to include in their curricula more subjects of other than a technical nature and it would seem to be well to place strong emphasis on subjects bearing on political matters. Moreover, while it is important that a student engineer have full realization of his lack of knowledge, care should be taken that this is not carried so far as to give him an inferiority complex. He should not only be taught to arrive at correct conclusions, but also to fight for his convictions based on those conclusions. On the other side of the picture is the necessity to work smoothly with others—team work is needed if any project is to be carried through.

One educator who thoroughly believed that young engineers should know about the practical workings of politics arranged that certain of his students work in house-to-house political canvasses, paying them from party funds for the service. The engineer should acquire an understanding of the practical workings of politics in order that any criticisms will not appear naive. Moreover, he must not be "thin skinned."

Many engineers lack the ability to speak well before an audience or to think on their feet. It may be that something more can be done about this in school, but it is probably best overcome by practice and the young man should force himself into situations where he would acquire that practice. In my class at school was a man several years older than most of us who had been a city councilman and had engaged in many ward meetings. He was able to express himself clearly in class with no inhibitions and was the envy of his classmates.

However, it is not particularly those of student age who lack interest in public affairs. The man in his thirties and forties finds himself busy with his work, with his professional societies and with his family. His political activities, which are usually discouraging at best, are pushed aside and town and city affairs are left to others.

It appears that there must be some sacrifices of time, of money, and of peace of mind on the part of engineers—as well as of other professional and business men—if such men are to have a real part in government. Certainly the training of the engineer as well as of the businessman in securing full value for money expended would

help in the business of government.

To summarize—if we are not satisfied with the way public affairs are run, let's get into those affairs, not as a group but as individuals with full realization that there must be personal sacrifices and that most individuals must start in minor roles. We can justifiably feel that engineers can be of help in the business of government.

THE MYSTIC CABLE TUNNEL DESIGN AND CONSTRUCTION

(Presented at a meeting of the Designers Section held on December 12, 1945.)

BY OSCAR S. BRAY*

In 1941, the Boston Edison Company began construction of its Mystic Station, on the north bank of the Mystic River, in Everett, Mass. The initial development included installation of two 50,000 KW turbo-generator units, extensive switching facilities and construction of a suitable connecting link between the generating station and that portion of the Company's distribution system to the south of the river. It is with the type selection, design and construction of this link that we are here chiefly concerned.

Basic specifications set up for the connecting link were as follows:

1. It must provide the maximum practicable reliability of service.
2. It must possess sufficient initial capacity for current needs, with additional capacity available or readily added for future requirements.
3. It must require a minimum of maintenance.
4. The facility must fit within the space limitations of the site, both during and after construction.
5. The cost must be reasonable, considering the nature of the service to be performed.

Preliminary studies, while covering a great many individual schemes, may be grouped in four general classes, these being:

- a. Submarine cables, laid unprotected.
- b. Submarine cables laid in prefabricated conduits.
- c. Overhead construction.
- d. Tunnel.

Of all schemes considered, only "d", the tunnel, met all of the specification requirements. Submarine cables, low in first cost and easy to install, were known to be subject to various types of failure in service and, more serious, were known to have failed occasionally while held in reserve as spares. The possibility of disturbance and damage by

*Assistant Chief Structural Engineer, Jackson and Mooreland, 31 St. James Avenue, Boston, Mass.

river traffic or dredging operations also weighed against this class of construction. Use of prefabricated conduits for protection of the cables alleviated, but did not eliminate the objectionable features of the unprotected cables while adding appreciably to the cost. Overhead construction was rejected as impractical because of space limitations, foundation conditions (to be discussed later) and the number of circuits desired, 15 to 18, involving from 45 to 54 cables exclusive of spares.

The following primary considerations governed the design of the tunnel.

1. The capacity when fully developed, should be sufficient to meet foreseeable station requirements. This was set at 18 circuits of 3 cables each, with four spare cables.

2. The tunnel should provide sufficient space for convenience in cable installation and servicing.

3. The design should lend itself readily to construction, using accepted materials and methods. Final design was influenced to a greater or lesser degree by each of the following factors:

- a. The character of the ground as revealed by the borings.
- b. The possibility that a shield might be required.
- c. The space available for construction plant and operations on both the Everett and Charlestown sides of the river.
- d. The anticipated need for temporary tunnel wall support and the types of support available.
- e. The problem of providing for drainage during construction.
- f. The relative facility with which the lining could be installed.
- g. The method to be used in sinking the tunnel shafts. (Shafts were accepted as necessary early in our thinking due to site limitations.)
- h. Structural efficiency of the tunnel lining.

Space requirements in the tunnel tube and other pertinent factors resulted in selection of an 8-foot inside diameter circular section containing two 29-duct banks arranged on each side of a central walkway. Space requirements for cables and access fixed the shaft cross section at 15' square, with an 18-foot by 30-foot underground splicing chamber atop each shaft.

Tunnel location was determined principally by space requirements and station arrangement on the Everett side of the river. The generating station had been located close to the river and about mid-

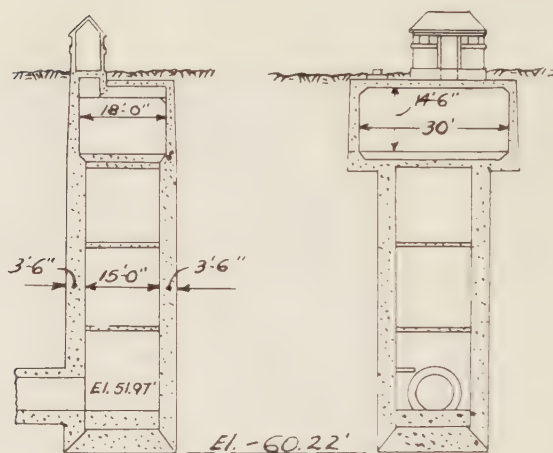


FIG. 1.—SHAFT AND SPLICING CHAMBER

way between the east and west side lines of the lot, with coal storage and handling facilities to the east and switching facilities to the west. The screen well and pump house for condenser water intake was placed opposite the turbine room, located on the west side of the station. The plant was planned to grow to the north, with intake facilities expanding to the west along the river. Thus the Everett terminus of the tunnel was placed convenient to the switch yard and clear of the west edge of the ultimate intake development. Location of the Charlestown terminus was fixed by the necessity for clearing existing installations while keeping as close to Alford Street, along which the connecting ducts were located, as was practicable.

With tunnel alignment determined, a series of borings were made, one at each shaft location and ten at 100 foot intervals along the length of the tunnel. These latter were staggered alternately to the right and left of the center line and clear of the tunnel to avoid creation of a blow-out hazard during construction, should compressed air work be required.

The borings showed the material under the river to be silt, sand and gravel, a medium to soft blue clay containing occasional sand lenses, and, at lower levels, sand, gravel and clay in various combinations. (See Fig. 2.) Consequently, the tunnel gradient was fixed at mid channel at an elevation just sufficiently low to provide 10 feet of cover over the top of the tube, assuming that the river might some

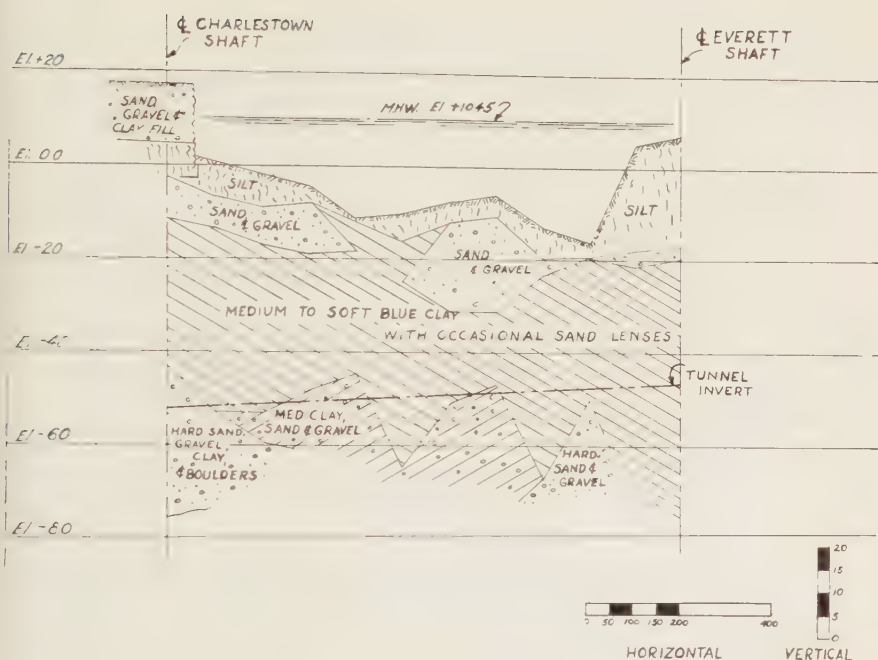


FIG. 2.—SOIL PROFILE

day be dredged to provide a low-water depth of 30 feet. This kept the tunnel largely in clay, considered a more desirable tunneling medium. In view of the congested conditions prevalent at the Everett end by reason of the construction activity there, it was decided that the tunnel should be driven from the Charlestown side of the river. To facilitate drainage during construction as well as to assist in tramming out muck, the tube was given a $+0.5\%$ slope to the north, fixing the floor elevation of the Charlestown shaft at -51.97 and that of the Everett shaft, 1100 feet distant, at -46.47 .

The borings indicated that the lower portion of the Charlestown shaft and a short section of the tunnel adjoining it would lie in a compact formation of sand, gravel, boulders and clay containing some water. The Everett shaft was expected to bottom in soft clay containing some fine sand. These conditions, the depths of the shafts and the fact that shaft wall thickness as determined by strength requirements would provide almost enough weight to make the shafts

self-sinking led us to conclude that the most practicable method of constructing the shafts was as open caissons.

Design of the shaft walls thus had to satisfy two criteria, viz:

1. They must be sufficiently thick to resist anticipated soil pressures without use of excessive reinforcement.
2. They must possess sufficient weight to overcome skin friction during sinking, this being estimated at about 400# sq. ft.

In satisfaction of these two requirements, shaft walls were made uniformly 3'-6" thick, giving the caisson an exterior surface area of 88 square feet per foot of height and a corresponding sinking weight of some 39,000 pounds, sufficient to overcome about 440# sq. foot of skin friction. External pressure was assumed to vary uniformly from ground surface to bottom of shaft in accordance with the formula $p = (64 + kw_s^1)h$, in which

p = external pressure, #/sq. ft.

w_s^1 = buoyant weight of soil

k = soil pressure coefficient

h = depth beneath the surface.

Soil was assumed to weigh 110 pounds per cubic foot, giving a buoyant weight of 46 pounds per cubic foot, and k was taken as 0.67. The formula thus reduced to

$$p = 95h,$$

giving a maximum value for p of 6900# sq. foot. The writer believes this value to be somewhat on the high side for the Charlestown shaft,

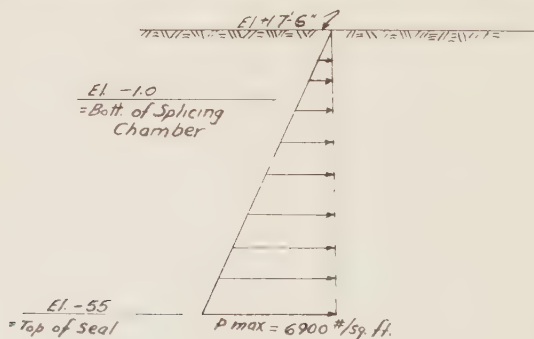


FIG. 3.—PRESSURE DIAGRAM—SHAFT WALL

with its lower section in a sand-gravel-clay formation, and perhaps slightly below actual pressures ultimately developed by the clay at

the bottom of the Everett shaft. It will be noted that the formula used assumes saturated soil to the ground surface, whereas the actual saturation line was some 5 feet lower. Shaft sides were considered to act as a series of rectangular frames, the amount of reinforcing used varying by steps with the depth beneath the surface to compensate for the triangular pressure distribution diagram and the resulting moment. Generous fillets were provided in the interior corners to assist in resisting negative moment and particularly, to avoid heavy stress concentration in those locations. Incidentally, these fillets later proved of value in facilitating form stripping.

Inability to obtain steel plate during those critical days in 1942 forced us to design the cutting edges for use of such shapes as could be cut from some available wide-flange beams salvaged from bracing used in the screen well cofferdam at the generating station, supplemented by large angles cut from some scrap MZ-38 sheet piling. The cutting edge proper was formed by a heavy T cut from a 30" wide flange 200 π beam, reinforced and stiffened by counterforts cut from the web of that same beam. The edge was tied to the caisson concrete by a series of vertical and inclined tees to which the caisson

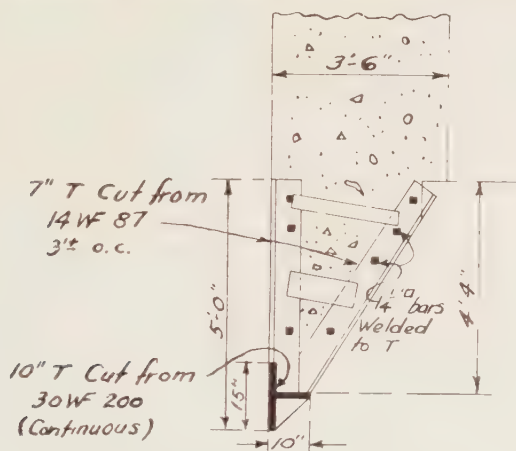


FIG. 4.—DETAIL OF CUTTING EDGE

reinforcing was welded. This improvised cutting edge functioned satisfactorily in operation, though it was never forced through ground which tested it conclusively.

The construction plan tentatively adopted for shaft and splicing chamber during early stages of the design called for construction of a steel sheet pile cofferdam, of sufficient size to enclose the splicing chamber, with piles driven deep enough to seal the piling in impervious material below the bottom of the chamber. This cofferdam was to be excavated and braced, following which the shaft caisson was to be constructed and sunk and the side walls and floor of the splicing chamber built. The splicing chamber roof was not to be installed until after excavating and lining of the tunnel had been completed, in order to provide the maximum of access. It was also planned to pull the sheeting and remove the bracing from the Charlestown cofferdam as soon as the splicing chamber walls were completed, and to re-use this material on the Everett side of the river. Consequently, the splicing chamber walls and floor were designed to resist the cantilever moments resulting from back filling before addition of the roof.

It was expected that the shafts could be sunk and the tunnel started without use of compressed air. The possibility that this might not prove feasible was recognized, and provision was made in the shaft walls for anchoring a temporary concrete air deck to permit the use of air should its use be necessary or desirable. Subsequent events demonstrated the value of this provision.

Two intermediate concrete floors were provided in each shaft, these serving the dual purpose of providing landing and working platforms and forming lateral supports for the duct line risers.

Design of both shafts and both splicing chambers was identical except for slight differences in grades and for omission of diagonal bars in the Everett shaft walls by reason of the higher diagonal tension value in the concrete permitted in Everett.

Perhaps the most interesting single problem of design encountered on the tunnel project was design of the lining itself. In view of the nature of the ground—saturated clay for the most part—it was concluded that the ultimate (long time) pressure on the top of the tunnel would amount to full hydrostatic pressure plus full weight of the overlying earth, or about 6500 pounds per square foot, that this pressure would decrease uniformly to 4500#/sq. ft. at mid height of the tunnel section and would then increase to about 7000#/sq. ft. on the bottom. Thus, the loading diagram had approxi-

mately an egg-shaped form with its long axis vertical.

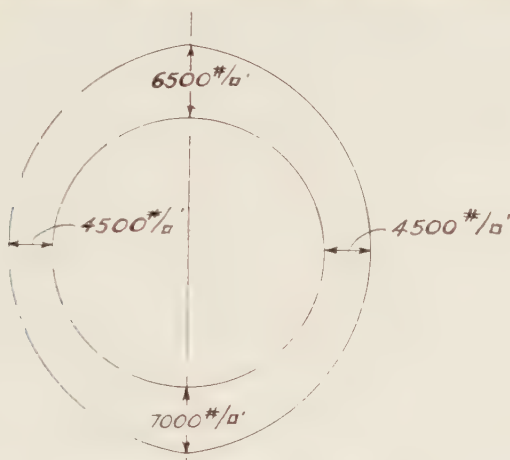
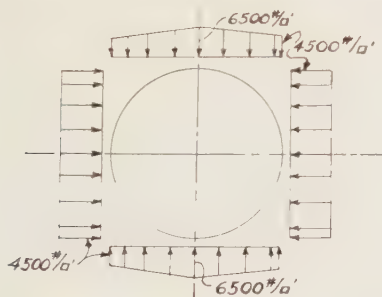
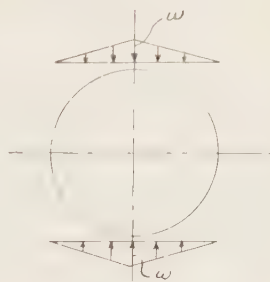


FIG. 5.—ANTICIPATED PRESSURE

To make this loading more amenable to treatment without resorting to a cumbersome equation, the indicated simplification was adopted. w being the difference between top and side pressures. The weight of the tunnel itself, considered in the basic loading diagram, was disregarded in the simplified version, it being felt that the accuracy of the basic assumptions did not justify this refinement. It was further assumed that only the triangular portion of the top and



SIMPLIFIED PRESSURE DIAGRAM



PRESSURE DIAGRAM FOR MOMENT

FIG. 6.

bottom loading was effective in producing moment in the lining ring, the remaining loads amounting to a uniform radial pressure producing compression only.

Determination of the direct forces existing in the ring within the accuracy required was neither difficult, interesting nor worthy of discussion here.

Determination of the bending moment under the assumed loading, however, produced an interesting problem. It was solved in this manner.

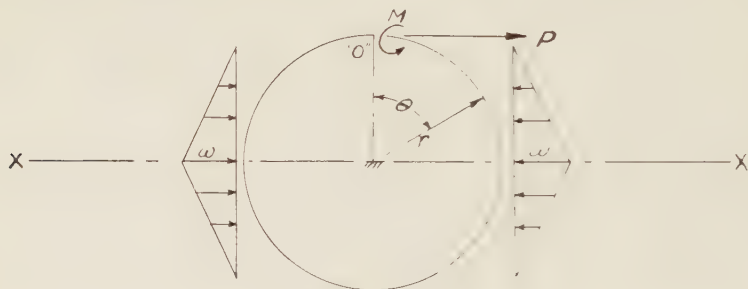


FIG. 7.—CUT RING AND LOADING

The solid ring, fully loaded, was assumed to be cut at "O" (Fig. 7), one side of the cut section being assumed supported and fixed by an infinitely stiff but weightless member. The free side of the cut was considered to be maintained in its uncut position by the force "P" and the moment "M". The cut ring thus becomes a curved cantilever beam fixed at "O" and acted on by the loading, the force "P" and the moment "M". Then ϕ , the deflection of the tangent to the elastic curve at "O", is equal to

$$\int_0^{2\pi} \frac{M_c ds}{EI}$$

where M_c is the moment produced in the cantilever by the loading. Since by definition M is that moment sufficient to maintain the tangent at the free end of the cut ring in its original or uncut position, the tangent deflection produced by M must be equal and opposite to that produced by the loading,

$$\text{or} \quad \int_0^{2\pi} \frac{M_c ds}{EI} = \frac{2\pi r M}{EI}$$

$$\text{and } M = \frac{\int_0^{2\pi} M_c ds}{2\pi r}$$

Now, let δ_x equal the deflection in the x -direction produced at the free end of the cut ring by the loading. Then

$$\delta_x = \int_0^{2\pi} \frac{M_c Y ds}{EI}$$

equal and opposite to the deflection produced by P , $-\frac{P\pi r^3}{EI}$

$$\text{or } \int_0^{2\pi} \frac{M_c Y ds}{EI} = -\frac{P\pi r^3}{EI}$$

$$\text{and } P = -\frac{\int_0^{2\pi} M_c Y ds}{\pi r^3}$$

Since the loading considered produces no shearing force at "O" a similar expression for V , based on deflection in the Y direction, need not be developed.

With expressions for M and P available, the expression for moment at any point in the ring produced by the assumed loading may now be computed—somewhat laborious—and set down as

$$M = M_c + .346 wr^2 - .500 wr^2 \cos \theta$$

$$\text{or, where } \theta = \frac{\pi}{2}, M = +.179 wr^2$$

$$\text{and, where } \theta = \pi, M = -.154 wr^2$$

In the above expressions, positive moments produce tension on the inside face of the ring.

Various lining thicknesses were investigated, the choice finally narrowing to one between 12" and 15". Maximum tensile stresses produced in the lining by the assumed loading were computed as follows:

$$12'' - 200 \text{ p.s.i.}$$

$$15'' - 113 \text{ p.s.i.}$$

These stresses occurred on the inside face, at the top and bottom of the lining ring. It was felt that the 5200 p.s.i. concrete to be used in the lining could safely withstand 113 p.s.i. in tension but that tensile stresses of the order of 200 p.s.i. would require use of re-

inforcement. It was believed that use of reinforcement in the lining would complicate construction and concrete placement to such a degree as to make use of the thinner reinforced lining uneconomical. Consequently it was decided to use the 15" thickness. This choice was confirmed by the contractors when bids were taken.

The contractor elected to follow closely the construction plan contemplated by the designers. He set up his plant adjacent to the Charlestown shaft, the compressors, emergency generator and hospital lock being located on a barge moored alongside the Alford Street Bridge. Following construction and excavation of the Charlestown splicing chamber cofferdam, the cutting edge for the shaft caisson was erected on wood sills and three 12-foot high wall "lifts" were concreted. Sills under the cutting edge were then chopped away and sinking started, excavation being carried out by means of a clamshell bucket and hand trimming. Construction of additional lifts and sinking of the caisson alternated until the cutting edge reached grade, when the bottom was cleaned out, a filter layer of gravel was added and the reinforced concrete seal placed. Bleeder pipes were installed through the seal to prevent development of excessive hydrostatic pressure on the green concrete.

An "eye" had been left in the shaft through which the tunnel proper was to pass, this eye being closed during sinking of the shaft with a wood and steel bulkhead. The "eye" was ballasted during sinking with sufficient pig iron to equal the weight of the concrete displaced, the purpose being to balance the caisson and prevent "drift." Following installation of the bottom seal, the ballast and the bulkhead closing the "eye" were removed and an attempt was made to open the tunnel in free air. Free air tunneling proved to be totally impracticable because of water and soil conditions. The attempt was halted while an air deck was constructed in the shaft and air locks were installed. The lower portion of the tunnel shaft and the working face were then placed under slightly more than 25 p.s.i. air pressure and tunnel driving was resumed without further trouble.

When approximately 50 feet of tunnel had been driven and lined, two heavy concrete bulkheads with air-tight doors were installed in the tunnel to form the "permanent" construction air lock. The shaft air locks and air deck were then removed and tunneling proceeded under air pressures of the order of 25 p.s.i.

Mining in the tunnel was carried out by hand methods, supple-

mented by air-operated clay spades. Excavation procedure varied with the ground conditions but generally followed the pattern next described. The upper half of the section was advanced a distance of 8 to 15 feet and the upper half of the temporary lining, consisting of standard formed segmental plates, was installed. The lining was supported temporarily on blocking resting on the bench. With the upper portion of the lining in place, the lower half of the heading was cut out and the bottom plates installed, the upper section being carried meanwhile on jacks and shoring.

Excavated material was hand-loaded into skips on narrow gauge cars, which were readily shifted by hand. It was found entirely practicable to excavate the clay closely enough to the plate line to make packing or grouting outside the temporary lining unnecessary.

When the heading had been advanced a minimum of 10 feet the steel forms for the concrete lining were brought ahead, aligned and filled. Concrete was delivered by car over the tramming track, shoveled into the forms and compacted by internal vibrators and hand spading. Concrete in the crown section was mixed with a 1" slump or less (in contrast with the 2 to 4-inch slump concrete used in the balance of the lining) and was rammed into place. Construction joints in the lining were of the plain butt type, without dowells, reinforcing rods or special sealing devices.

Voids in the lining were filled with cement grout injected through fittings inserted in holes drilled in the concrete. Initial grouting was done while the tunnel was still under air pressure, and generally about 10 days after concrete placement. Final grouting was delayed until the tunnel driving had been completed and the air pressure removed to permit detection and correction of leaks not apparent with the tube under pressure. Both Type II and Type III cements were used for grouting work, with no appreciable difference in operation or results. Grouting required in all approximately 1800 barrels of cement.

Construction of the Everett shaft was started when about 40% of the tunnel had been driven, using the method followed for the Charlestown shaft. Working space limitations and shaft location made the use of floating equipment convenient and economical, consequently, this shaft was worked from the water side. Sinking proceeded without incident until the cutting edge was about 15 feet above grade, when the caisson lodged. The structure was loaded with

about 200 tons of pig iron and sinking was resumed. Skin friction at this time was estimated at about 625 pounds per square foot.

Shortly before bottoming, the cutting edge passed into a saturated layer of fine sand and silt. A considerable inflow of water occurred and it was feared that further drainage of the underground, coupled with the possible loss of ground, might produce undesirable settlements in neighboring structures, particularly those on piles whose tips bore on a soil stratum well above the bottom of the caisson. To avoid this possibility, air locks were installed and the caisson completed under pressure.

Tunnel design required use of two grades of concrete, a 4500 p.s.i. mix for walls, floors and seals of the shafts and a 5200 p.s.i. mix for all other work. Concrete was delivered to the job in 5.5 C.Y.

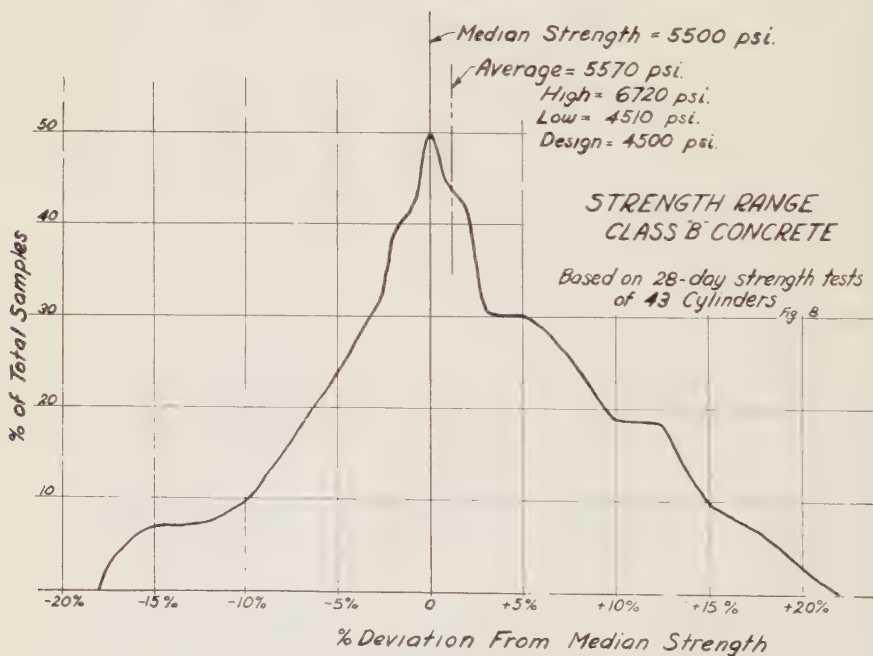


FIG. 8.—STRENGTH RANGE CLASS "B" CONCRETE

truck-mounted mixers from a commercial plant. Careful control of materials, proportioning, mixing, placing and curing produced concrete which consistently tested above the design strength.

This structure has to date performed satisfactorily and about as expected. Leakage has never attained important proportions, now running about 4 g.p.m., with the bulk of the leakage occurring at construction joints. Experience to date leads the writer to the following tentative conclusions.

1. Use of low w c ratio low-slump concrete is most desirable for work of this type.
2. Placing methods for crown concrete need improvement to insure full forms and dense concrete. Most leakage troubles both at joints and elsewhere have developed in the upper quadrant of the lining.
3. Tight forms are essential if a tight tunnel lining is to be secured, leaks in the lining being frequently observed where form joints leaked.
4. An improved construction joint for the lining should be developed to prevent leakage and at the same time permit the limited movements occasioned by shrinkage and temperature changes.

USE OF PLASTICS IN CIVIL ENGINEERING

By E. S. CHILDS*

(Presented at a meeting of the Boston Society of Civil Engineers held on February 20, 1946.)

I. INTRODUCTION

FEW products of industry have ever experienced the world wide interest that has been focussed on plastics as a result of their phenomenal record of exceeding the expectations of many in countless applications under wartime conditions. Persons in all walks of life have been prompted to seek information about plastics. Typical questions asked are: What are plastics? How are they made? What will they do? The designer or engineer expresses his questions in a different way, he asks: What are they good for? What are the properties, methods of fabrication, and cost as they apply to a particular problem? It is this latter type of question I will discuss this evening. First, however, we will get a general idea of what plastics are.

The assertion was made centuries ago that there is nothing new under the sun. Then, the ambitions and desires of Man aroused inventiveness and resourcefulness. He undertook to utilize already old and well-known materials in making others which would help him achieve his ambitions. Down through the years, article after article, made from nothing new, appeared and came into regular use which expanded as improvements and refinements were developed.

This growing tendency to employ commonly-known basic materials received tremendous impetus when Man undertook to explore the field of chemistry. He discovered that these basic materials are made up of links or chains of atoms which could be broken down or combined in differing ways and that such combinations produced new materials having a wide variety of uses. The story of plastics is an example of the age old search for new and better materials to replace natural ones used up, or to perform functions more satisfactorily than materials available.

The ability of Man to imagine things that he doesn't see and to fashion these things from what he finds around him is responsible

*Plastics Division of Monsanto Chemical Co., Springfield, Mass.

for plastics. To illustrate this point and at the same time to indicate how plastics are related to other industries I will cite a case from Monsanto's log of experience.

In 1937 Monsanto undertook a research program to develop a process for manufacturing styrene, at that time a promising new prospect for the plastics industry. Utilizing petroleum and natural gas raw materials a satisfactory procedure was developed and a plant was constructed in 1942 to produce 50,000 tons per year. Up until this year not a pound of the styrene produced in this plant has been used in making plastics. As you know, styrene was selected as a basic ingredient for the Buna S or GRS type synthetic rubber. It was fortunate that Monsanto had its research program to the stage where data was available for large scale design, for it enabled the company to construct and place in operation the first government financed plant for the manufacture of styrene, so vital to our defense program. Thus the same material is an ingredient of synthetic rubber and a plastic.

Another example of how plastics are related to other industries is the case of synthetic textiles. Here the same raw materials that go into synthetic fibers are also widely used as common plastic articles in your every day life. Cellulose acetate rayon and your cellulose acetate automobile steering wheel are one and the same substance, only in different physical form. In one case it's a textile, in the other a plastic.

Often the use of plastics in such related fields exceeds its use in the common molded and fabricated form. For example, the Duco automobile finishes which replaced varnishes are cellulose nitrate. Finishing a varnished car took about three weeks of successive coating, drying and rubbing. Nitrate lacquers reduced the time to a matter of hours.

This coating material is as much a plastic as your drawing triangles and French curves. Similarly the use of phenolic resins as the first baking enamels at times exceeded their use in such plastic objects as molded radio cabinets and telephone handsets.

The plastics industry has undergone a revolution in the last decade. Whereas formerly plastics were used mainly in colorful costume jewelry, artificial collars and cuffs, automobile side curtains and in novelties and toys, today their applications have increased

many fold into related industries such as those of synthetic rubber, synthetic textiles, and coatings.

The increase in production of synthetic resins in the last decade as reported by the Department of Commerce has been approximately 1300%, from 43 million pounds in 1933 to 650 million pounds in 1943. Mr. W. S. Landes, President, PMMA, reports that although prices of many types of plastic materials declined during the period from 1939 through 1944, total dollar volume of the industry in the U. S. increased 325%. Mr. Landes also reports that the plastic materials producing industry has progressed twenty years in research during the five years, of intensive devotion to war.

II. GENERAL CHARACTERISTICS

At the present time there are more than twenty commercially available plastic materials which vary widely in their individual characteristics. In this respect they are similar to metals: One plastic is as different from another as steel is from aluminum, or as lead is from brass. If you were preparing a drawing of a new railroad frog, you wouldn't think of specifying the material as "metal". That is just as unreasonable as the case of a designer labeling a part with the word "plastic".

Plastics are synthetic materials, that is, they do not occur in nature, but have been put together, or synthesized by man. Hence, it is possible to produce materials which are actually "tailor-made".

Despite the many different types and hundreds of formulations of plastics there are certain properties which are characteristic of all the materials. Again comparing plastics with metals, even though there are countless varieties of metals and alloys they have certain properties in common. For example, all metals are conductors of electricity. Some more, some less, but generally it can be said that all metals are conductors. Similarly all plastic materials have certain characteristics which are common to a greater or lesser extent.

The first of these general characteristics is light weight. All plastics are lighter than aluminum. The specific gravities will vary from 0.9 to 2.0. This property of plastics enables them to compete with other construction and engineering materials. For even though plastics are generally more expensive than the common engineering materials the fact that more finished articles can be obtained per pound from plastics tends to counteract the price disadvantage.

Light weight permits plastics to replace other materials in many established applications. As an example, weight is important in all commercial transportation vehicles. A reduction in weight permits greater payload or reduced power requirements in aircraft and railroads, larger size for the same weight in trucks and busses. Lighter weight permits reduction in design loads with consequent savings all along the line.

Light weight is important in luggage. In an air-minded age where weight limitations are imposed on baggage, a lightweight plastic case allows you to carry heavier contents without extra charges.

Human comfort is also increased by lightweight plastics, as in the case of wearers of hearing aids. A molded plastic case saves precious ounces as compared with stamped metal.

The ladies also enjoy the advantages of lightweight plastics. Their raincoats need no longer be bulky rubber or heavy cloth. Plastic coated high tenacity rayon or plain plastic film raincoats are featherweight and also brightly colored. Likewise milady's handbag is lightened by the use of plastic cosmetic containers.

Another interesting general property of all plastics is their insulation characteristic. Their low heat conductivity makes them warm to touch, a fact appreciated in hardware knobs and handles. Unlike metals which are electrical conductors, all plastics have electrical insulating properties. It has been generally stated that 50% of all plastics used are in articles where electrical currents are handled.

The best known plastics for electrical apparatus are the phenolics, the Bakelite type materials used so extensively for molded terminal blocks and switch bases, and in laminated form as panels. Your telephone handset is probably the most conspicuously successful application of phenolics in electrical components. It is a fine example of what an intelligently conceived, carefully engineered, and well-executed application of plastics can deliver in terms of an improved product for long service.

Two outstanding large volume plastics insulating applications were developed during the war. The first was the use of vinyl plastics to replace rubber as wire and cable insulation. The materials provided good insulation, permanent flexibility, a high degree of toughness, abrasion resistance and extensibility. Of particular importance on shipboard was their flame resistance. As a result of

their satisfactory service, these vinyl materials will doubtless be extensively used postwar replacing rubber in electric wire and cable insulation.

The second outstanding war application demonstrating the insulation properties of plastics was the use of styrene, its derivatives and copolymers in high frequency radio and radar sets. The materials provided electrical characteristics superior to mica. The ease of molding them to intricate and dimensionally stable shapes made them more desirable than ceramics, and the inherent light weight was an important factor for aircraft, and walkie talkie sets. Typical uses were coil forms, resistors, crystal holders, tube bases, and condenser and capacitor parts.

Chemical resistance is a third characteristic common to all plastics. They will not rust, corrode, tarnish, mildew or rot. They generally lack odor and are non-toxic.

These properties are best illustrated by the kitchen utensils, and refrigerator compartment panels in every home.

An interesting war application illustrating chemical resistance was the use of styrene in battery cases for aircraft. The use of molded plastics resulted in an appreciable weight reduction while at the same time providing satisfactory resistance to the acids encountered.

Chemical resistance is largely responsible for the manner in which your car's alkyd finish stands up. This baked plastic enamel withstands heat and cold, it does not break down when exposed to the strong actinic rays of the sun or the abrasion of a gritty wiping rag and it is more resistant to the salt encountered on northern U. S. roads in the wintertime, than the chrome plated bumpers and trim. Oil and gasoline spilled on the fenders does no permanent damage.

To Engineers, perhaps the most interesting general characteristic common to all plastics is the adaptability of the materials to mass production. To understand this it is necessary to digress for a moment and to consider the various forms in which plastics are available. First, plastics may generally be broken down into two types determined by their reaction to heat. These two types are called thermosetting and thermoplastic. The thermosetting type materials first soften under heat and then harden or set to infusible masses. Additional application of heat will not soften the thermo-

setting plastics. Thermoplastic materials on the other hand will soften under heat, and harden on cooling for an infinite number of cycles. Both thermosetting and thermoplastic materials are supplied in several forms: as granular molding compound, as sheets, rods or tubes, and as a liquid or powder. The three principal methods of molding the granulated powder are easy to remember because their names—compression, injection and extrusion—just about describe what takes place in each one. Each method requires a different type of molding machine, usually operated by hydraulic pressure and heated by electricity, steam or oil. In the press is placed a metal mold which has been constructed in the exact shape of the article to be molded. Some molds will form just one plastic piece, and some are built to mold several at a time, the way a muffin tin bakes several muffins.

In compression molding the press works with an up-and-down motion like an old fashioned butter churn. The plastic material is placed in the lower or hollowed-out half of the heated mold. As the press closes down, the upper half of the mold is forced into the lower half, like one nested block into another. The plastic material is squeezed or compressed between the two halves of the mold until it hardens into shape and can be removed. Thermosetting materials are usually compression molded.

Injection molding is done with a sideways motion, and you can think of the injection machine as a large horizontal pipe with an opening in the top at one end, the mold sitting in the other. The material is dropped thru the opening and melts because the pipe is hot. A plunger forces it thru the pipe to the other end and squirts, or injects, the hot plastic into the mold. The mold is cold and the material hardens into shape and can be removed. Thermoplastic materials are usually injection molded.

Extrusion molding is also done horizontally. The extruder is like a kitchen meat grinder: the material (a thermoplastic) is fed in at the top and a revolving screw drives it thru the heated cylinder to the far end where it is forced or extruded thru a die. The die has small openings, just like the kitchen meat grinder, and the size and shape of the openings determine those of the long spaghetti-like rods or tubes which are carried away on a moving belt to be cooled and dried.

Rods and tubes of plastic, like those of any other material can be worked into shaped articles with ordinary tools like saws, drills and lathes. Plastic sheets, which are sliced from big molded blocks much as the butcher slices cold meat or cast like sheets of glass, can also be sawed, drilled, stamped and bent into different shapes. We say that articles machined with tools from sheets, rods, tubes and other elementary shapes are fabricated, as opposed to the molded articles which, as you have learned, are formed by heat and pressure in steel molds.

Laminated plastics are produced by first coating or impregnating the material to be used (cloth, wood, paper) with a plastic resin and then putting it together in layers. These layers are placed between metal sheets and set in a huge press which heats them and presses them together into a solid sheet. Rods and tubes are formed by wrapping layers of plastic—impregnated sheets around master rods (called mandrels) and pressing or baking them until they are hard. Large shapes like boat hulls or airplane fuselages can be made by arranging the layers over wooden forms, placing them in rubber bags and baking them in big ovens until they are firm and solid.

Plastic coatings are applied by the same methods used for applying any other liquid substance—dipping, spraying, roller coating, brushing and the like. Plastic fibers are formed from a resin solution by a wet spinning or extruded like a plastic rod and tube.

Naturally all these processes for making plastics are a great deal more complicated than this brief account seems to indicate, and there are countless modifications of each of them.

Now that you have an idea of the forms in which plastics are available and the methods by which they can be formed into finished articles it is easy to understand that all the materials lend themselves to mass production. In the case of molding compounds once a steel mold is made up, hundreds of thousands and sometimes a million identical plastic objects can be rapidly and economically produced. The careful machine work represented by the mold is faithfully duplicated in every part made from that mold or die. To illustrate familiar objects so produced, consider bottle caps, buttons, combs, hardware and radio knobs, and handles, faucet and valve wheels, etc.

The extrusion process of forming plastics provides tubing and wire coating. Such structural shapes as beams, channels, angles, Z

and T bars can be formed in lengths required to meet particular requirements.

Parts can be stamped from plastics sheets in the same manner as from metal. Electrical insulating washers are made by the millions by this type of fabrication.

Plastic sheet materials lend themselves to drawing or forming into compound curved sections. An interesting war application was the use of formed plastic sheet materials for bucket type seats in aircraft. The use of plastics resulted in important weight savings, and the ability of the materials to be produced in volume permitted the manufacturer to keep pace with aircraft production requirements.

It should be pointed out, however, that there have been limitations in the past, and there still are to mass producing plastics. Of these size has been the most important limiting factor. The molding operation has been restricted by the size and capacity of machines. For example, a common injection molding machine injects only 8 oz. of plastic at each stroke of the injection plunger. The reason for this limitation is that high pressures are required to squirt the molten plastic into the mold, usually in the range of 20,000 psi. In the case of one typical 8 oz. machine 113,000 pounds is the total pressure on the injection plunger. This high plunger pressure necessitates higher pressures to keep the two halves of the mold together. This same 8 oz. machine has a total mold closing pressure of 250 tons with a maximum casting area of only 100 sq. in. Consequently, to get larger parts requires heavier and stronger machines. Last summer a Quartermaster Corps intelligence team investigating the German plastic industry found what are believed to be the largest plastic molding presses in existence, 5000 tons capacity. Recently in this country a middle western concern has produced an injection molding machine with a capacity of 80 ounces. However, such machines are still unique, and the largest capacity machines normally encountered in the trade inject between 22 and 30 ounces, with total casting areas of 210 sq. in. These machines have mold closing pressures of about 600 tons.

The plastic material manufacturers are actively researching to develop new materials and the machinery manufacturers to develop new methods by which plastics can be formed in large sizes at low pressures. The results of their efforts to date have permitted such articles as boats and aircraft fuselages to be made. However,

present forming techniques are not economical, and until they are your automobile and refrigerator will continue to be pressed from steel. The next five years will show impressive progress towards removing the present size restrictions.

The fifth general and the most striking characteristic that is common to all plastics is color. The materials are available in a range from crystal clear transparency through translucents and pastels to deep opaques. Literally, any color of the rainbow can be duplicated in plastics. From the salesman's point of view color is the most important characteristic of plastics, for psychologists claim that it is via the eye that the brain receives 85% of its impressions. Consequently, the quickest and most profitable route to a buyer's pocketbook is via the eye.

An important feature of color in plastics is that it is molded in, it is the same all the way through the material. Consequently, the color will not wear or rub-off. If a surface is scratched, it can be buffed up to regain its original lustrous appearance.

The ability of different plastics to be colored varies. The common Bakelite types for example have an inherent yellow cast which darkens with age and exposure to light. Consequently, they cannot be obtained crystal clear or pastel. Brown, black, and dark red, blue and green are the usual standards with phenolics.

The ureas and melamines on the other hand can be obtained white or pastel although transparents are still not feasible.

The majority of the other types namely, cellulose, vinyl, styrene and acrylate types, can be obtained colored over the full spectrum range.

A general characteristic of plastic materials of primary interest to engineers and designers is strength. In general it can be said that plastics are not as strong as metals as evidenced by standard physical test values such as tension, compression, flexural, and modulus of elasticity values.

However, a very small portion of plastics design has been based on physical test values. Reasons for this have been the lack of suitable testing procedures and the characteristic that test values of designed articles do not compare with physical test data obtained in standard tests. In other words a section designed to withstand a tensile load of 3000 psi will either fail or stand 5000 psi. Plastics, being relatively new and only recently considered as

engineering materials, have been tested on the machines and under conditions that are standard for other materials. That these procedures are not appropriate for plastics is evidenced by the fact that they often do not give reproducible results. For example, one uniform batch of material molded under identical conditions into Izod Impact test bars will give results that vary from 6 to 50%. ASTM flexural test values are better but give a variation of from 3 to 15%. Consequently, it has been very difficult to use physical test data in engineering design. This is further complicated by the fact that plastics are usually used in relatively thin sections and in complicated shapes. Rather than attempt to calculate the sections that will be required to resist known stress concentrations designers of plastics rely on past experience. They know from prior problems what type of designs have caused trouble and what types have been satisfactory. They select fillets, reinforcing ribs, and section thicknesses based on a knowledge of what happened to previous comparable designs. Users of plastics set up empirical tests to check the materials in their molded form. For example, telephone handsets are dropped from increasing heights. The height at which the molded article breaks must pass the standard set up. The nose cap on the Navy proximity fuse undergoes a different test. The tapered nose, about 5" diameter at the base, is clamped cantilever fashion and a two pound weight dropped to hit the cantilevered nose at a point 2" from the point. If the product does not break it is O. K. In the case of the phosphorous containing tube in the incendiary fuse, a pin must puncture one end. A good deal of difficulty was encountered in getting a material which would puncture as required. The plastics industry is cognizant of these shortcomings and manufacturers, molders and fabricators provide technical service representatives to discuss with a new user of plastics his projected application. Recognizing the tremendous interest that was developed in plastics as a result of its outstanding war achievements and realizing the complexity that must confront a potential user, Monsanto's Plastic Division has set up an advisory plastics technical council to consider problems of users of plastics. Plastic materials have grown so big, both in numbers and range of properties, and the fields of their applications have become so diverse that it is practically impossible for any one man to know all about plastics, to be able to diagnose completely every plastics problem

and to advise on every type of application. Monsanto's technical council is composed of ten experts, meeting regularly, who apply their specialized experience to manufacturers problems. Other firms in the industry have followed Monsanto's example, and through advertising new users of plastics are urged to avail themselves of the free council services.

Despite the fact that physical test data of plastics is difficult to apply to an engineering problem, it serves a very useful purpose. Early in the war the Army and Navy eagerly turned to plastics as replacements for critical metal and rubber materials. It was immediately obvious that comparisons with other materials based on physical and chemical test data would not permit reliable conclusions, because prior to that time there had been little standardization of plastic test methods, and practically no data was available which provided information on plastics at other than standard room temperature and humidity. The Army and Navy wanted to know how they reacted to extremes of cold, heat and humidity. They also had to have data which would enable them to select two or three out of the twenty odd general types for evaluation.

As a result of this situation the Plastics Committee D-20 of the ASTM prepared new and revised old standard testing procedures so that today we have rather complete comparative physical, chemical and electrical data on all the commercially available plastics. While this information is still not easily interpreted for design, it does permit comparisons between the plastics materials, so that by evaluating this comparative data the engineer and designer can usually arrive at a conclusion regarding the most satisfactory plastic for a particular application. The PMMA have compiled all this information in a booklet entitled "Technical Data On Plastics", a copy of which I have here if you are interested in seeing it.

In any discussion on general characteristics of plastics some mention should be made of price. The commercial materials vary widely in this respect, from $12\frac{1}{2}$ cents to \$5.00 per pound. The molding compounds, and the highest brackets apply to special color lowest price range applies to the general purpose phenolic type effects in sheet materials. While we are considering price, it should be made clear that contrary to popular opinion plastics are not made from waste materials. The properties of plastics raw ma-

terials are as closely examined and controlled as the chemicals from which pharmaceuticals are made. All the material manufacturers maintain control laboratories staffed by skilled technicians, whose sole purpose is to watch over raw materials and goods in process.

There is just one more property of plastics which should be mentioned in discussing general characteristics of the materials. While there are exceptions, it can generally be said that plastics do not stand up on outdoor exposure in a manner comparable to other engineering materials. Ultra violet rays from the sun usually darken plastics. Changes in temperature usually alter their physical properties. Some get brittle at low temperatures, and over a period of time others fail by fatigue from alternating stresses created by expansion and contraction. Most plastic materials will absorb moisture with resultant change in dimensions. In some cases the absorbed water leeches out ingredients in the materials with resultant decrease in strength. Two years useful service in an outdoor exposure would be the average life of most plastics. As I mentioned previously, there are exceptions to the rule as evidenced by plastic bonded plywood and the enamel on your car. As a general rule however, plastics cannot compete with other materials such as glass, steel and wood for outdoor service.

That discussion summarizes the general characteristic of plastics. It should be pointed out that there will always be exceptions, and as time goes on and newer materials are made available the range of properties of plastics will widen further.

III. GROUPS

As I mentioned earlier, there are about twenty commercial plastics. These can be grouped into a few general types, and since the engineering properties of the different plastics within a group are generally similar, it is interesting to consider them briefly.

The cellulose type materials are the oldest of the plastics. In 1869 John Wesley Hyatt combined cellulose nitrate with camphor in searching for a substitute for ivory with which to make billiard balls. His resulting plastic compound was Celluloid which is illustrated in your family albums of the horse and buggy era as stiff collars and cuffs, and shirt fronts. The second member of the cellulose group was cellulose acetate, introduced in 1912 by Eastman Kodak in the form of safety film. This same material wasn't used

as a plastic until 1927. In 1937 ethyl cellulose was on the market, in 1938 cellulose acetate butyrate molding compound and since several others.

This group of cellulose plastics are based upon cellulose from cotton and wood pulp. Plastics of this group are generally rigid, tough, and thermoplastic. They are transparent and can be readily colored. They are available in sheets, rods, and tubes and as molding compounds and liquids. They also have individual characteristics: Cellulose nitrate is flammable; cellulose acetate, the oldest thermoplastic molding compound, is readily adaptable to all forms of fabrication; cellulose acetate butyrate is characterized by unusual toughness and low water absorption, while ethyl cellulose has high strength at low temperatures.

The second general grouping is composed of the phenolic type materials. Leo Baekeland's Bakelite in 1909 was the first of this type. There are literally hundreds of variations of the phenolics, obtainable by the interaction of many different phenols, aldehydes or ketones and catalysts. The physical properties of the phenolic type plastics depend more upon the nature of the filler or extender used than on the base resin. For instance, wood flour is the low priced general purpose filler, mica is used where insulation properties are required, and asbestos for heat resistance. Fibers and rags are used for high impact strength.

The phenolic type plastics are available in many forms such as molding compounds, resin compounds, sheets, rods and tubes and as liquid resins. Common characteristics of this type are—rigidity, dark color, and the fact that they are all thermosetting.

A third general group of plastics are the amines, typified by ureas and melamine. This group is similar in many ways to the phenolics in that they are reaction products of aldehydes, are thermosetting and rigid. They have one significant advantage over the phenolics, which is color, and it is because they offer a wide selection of the most attractive colors that they find most of their uses. The importance of color restricts the fillers that can be used, consequently the urea and melamine compounds are not as versatile as the phenolics. However, electrical arc resistance of melamines is higher than the phenolics.

The fourth general group of materials are the vinyls. These acetylene derivatives are characterized by their elastomeric prop-

erties. It is from this group of materials that the plastic rubber substitutes were taken. The materials composing this group are polyvinyl acetate, polyvinyl chloride, copolymers of the two, polyvinyl butyral, and vinylidene chloride. One of the best known applications of this type of plastic is the use of the butyral as an interlayer between plate glass to form your automobile safety glass. Polyvinyl acetate is widely successful in adhesives, polyvinyl chloride is the wire coating compound, and vinylidene chloride, better known as Saran, is used extensively as chemical resistant pipe and tubing. The vinyl family of plastics are usually thermoplastic, but thermosetting types are also available. They can be obtained as sheets, rods and tubes, as liquid or powder, and as molding compounds.

A fifth grouping is more or less arbitrary, used because it includes two well known materials which have many similar characteristics. The two types of materials are the acrylics and styrene; both are thermoplastic, rigid and crystal clear, available as sheets, rods and tubes and as molding powders. The acrylics are widely known because of their outstanding use as aircraft windows and enclosures. Styrene is now the lowest price thermoplastic molding compound and when synthetic rubber production slackens, it will be available in very large volume for use in plastics. Both these materials take color well.

The acrylics are strong and tough and only half as heavy as glass. They withstand impact much better than glass and when broken do not shatter, but break into dull pieces which will not easily cut other materials. The coefficient of expansion of acrylics is much higher than glass and provisions have to be made for this in semirigid mountings.

Outstanding characteristics of styrene are superior electrical insulating properties, chemical resistance, and dimensional stability. Fairly recently copolymers of styrene have been announced providing still further improved properties.

There are several other different types of plastics which do not lend themselves to simple grouping. The polyamide type materials for instance are represented by nylon with its strength, and elasticity. Polyester type plastics are represented by Monsanto's new thalid resins, low pressure thermosetting laminating materials making possible the fabrication of large compound curved sections with

inexpensive dies. The Protein type plastics are represented by Casein and Soybean, the former used mainly in buttons while the latter has not yet established any significant commercial uses. Vulcanized fibers are another group of plastic materials whose properties can be varied widely to meet specific requirements. Cumarone-indene plastics modify other resins and bind mineral fillers for mastic floor tiling. Alkyd type resins provide hard, weatherproof, colored coatings.

IV. USES

Now that the plastics materials have been discussed generally, and you have been acquainted with their general characteristics, and a brief outline of their different groups or types, let us study some case histories which will give you a clearer idea how the materials are now used and how they might be applied to Civil Engineering.

In considering how plastics are used and how they can be used in fields related to the Civil Engineer the most logical starting place is the building industry. Referring again to Mr. Landes, the president of the PMMA, he has stated that it is possible for the building industry to use \$75,000,000 worth of plastics per year. This is rather startling at first thought because it represents 24% of the 1945 dollar volume of the plastics industry, but it is not so unreasonable when it is reconsidered as only 2% of the dollar volume of the building industry. The fact that plastics will play a larger role in the building industry is pretty well acknowledged, but opinion on the forms in which they will be utilized and applied differs widely. W. E. Reynolds, U. S. Commissioner of Public Buildings in 1945 stated in regard to small homes of the future that strong and light weight laminated wood roof trusses will eliminate the need of inside supporting walls, giving more freedom in room layout. Also, prefabricated walls will combine hard surfaced outside wall coverings, an insulation core, and smooth, washable, interior wall surfaces. He stated that there is considerable interest in paper faced plywood, impregnated with synthetic resins in pastel shades which can be washed easily and look new indefinitely. This type of wall material replaces lath and plaster which has to be painted or papered regularly.

The F. W. Dodge Corp. reports on Construction Potential that

development of plastics as structural materials might in time considerably modify construction methods, architectural style and furniture design producing greater values per building dollar.

In the fall of 1945 the architect Paul Robinson Hunter was commissioned by Pacific Plastics, a trade magazine, to study the present and future uses of plastics in building. Some of the keynotes of his report follow.

Monocoque design is a more appropriate structural use of plastics than present skeleton type where loads are carried by inner frame works.

In aircraft two skins of glass fibre reinforced plastics over a balsa wood core proved 50% stronger than metal fabrication on a strength weight basis. Laminated glass cloth has developed T.S.'s of 160,000 psi, greater than piano wire, and impact strengths superior to armor plate.

Electronic heating for large thermosetting parts and low pressure laminating are eliminating size as a restrictive factor in plastics applications. Molding of stairs, shower enclosures, and closets would offer no difficulties to an engineer accustomed to aircraft design.

During the war period there was a great development in the lamination of wood for structural members. The use of large natural timbers has never been entirely satisfactory. As the timber air dries, it shrinks, checks and warps, with consequent loss of structural value. There may also be hidden defects which cannot be discovered visually. During the past few years it has become increasingly difficult to obtain logs of diameter and length suitable for large timber.

Laminated lumber is fabricated from kiln dried wood of random lengths and is scarf jointed to any length by heat treatment. The greatest architectural interest is in laminated arches. The shapes are not confined to arcs of circles, but may be elliptical or parabolic or they may be compound or reverse. The thickness of the section may vary in the length of the arch, the greatest thickness occurring at the point of greatest stress.

The all-glued wood frame building is rapidly becoming a practical and economic feasibility. During the war many housing units were erected of prefabricated panels of plywood glued to both sides of 1" studs. Tests conducted recently on full scale wall sections reveal that diagonal sheathing on 2" x 4" studs on 16" centers has

twice the strength of nails, and that of horizontal sheathing has 4 times the strength of nails. In these tests the failures did not occur in the glue line but in the wood fibres.

The development of a full line of synthetic resin adhesives for the building industry foreshadows the fabrication of larger wall and roof sections, the use of lighter materials thoroughly stressed and bonded together with glues and the more rapid, less expensive erection of structures on the site.

Plastics adhesives have also removed from plywood the limitation of single panel size. Presses determine the maximum width, but by scarf jointing the ends of panels they may be bonded together to any length consistent with transportation facilities.

New wall panels are easy to handle and install. They are durable and quickly cleaned.

In addition to these general remarks on present and future uses for plastics, I have a list of several applications where plastics are now serving the building industry.

Concrete form and exterior grades of plywood as well as laminated arches, are bonded with synthetic resins. The use of plastic adhesives provide with the cross graining dimensional stability superior to all other wood based construction materials. Also these adhesives are generally rot resistant, termite proof, and flame resistant.

Plastic impregnated plywood is used as table and bar tops, and as decorative wall panels. In this case plastics provide surface hardness, stain proofness, cigarette resistance, and durable color. Textiles and papers can be laminated as surface layers in such panels to give a wider range of attractive designs, and by embossing plain colors, the panels simulate tile.

Floor coverings utilize plastics as in the case of coumarone-indene resins in "mastic" type tile. The use of plastics provide oil resistance, abrasion resistance, ease of application, low cost, greater beauty, resistance to water and alkalies, and durability.

Of notable interest is the use of plastics as wire insulation. In addition to supplying all the necessary properties as described earlier the use of plastics permits thinner insulation than with rubber. This peculiarity has recently saved a good deal of money and inconvenience to remodelers of office buildings and apartments. In modernizing these facilities rewiring has been necessary to permit increased

use of electric appliances, such as stoves, washing machines, and refrigerators. By using the thinly covered plastic coated wire it is possible to pull more conductors through a given conduit, thus saving considerable replacement.

Hardware is using plastics more extensively, primarily because of the adequate strength, attractive colors, and resistance to tarnishing and corrosion.

Electrical components installed by builders are very large volume applications for plastics. Main reasons for their use are low weight, ease of molding to intricate shapes, ability to receive inserts, electrical insulating properties, serviceability, low cost, good appearance, and resistance to corrosion.

Builders tools are using larger quantities of plastics. The familiar amber screw driver handle provides light weight, permanently solid attachment to the metal rod, electrical insulation, and toughness to withstand abusive handling. Power tools use plastics in electrical parts, and as handles and guards. The reason for their use is largely that they provide superior properties to alternative materials. As bonding agents for abrasives plastics are used in grinding and cutting wheels, and as non-slip spray or trowel applied floor coverings.

In industrial and office buildings, fluorescent lighting is common. The so-called "grave stone" tube sockets are of low weight plastic material which has heat resistance with satisfactory electrical insulating properties, and adaptability to mass production. The diffusing fluorescent shields are usually of plastic. They are light in weight, have high light transmission, a high degree of diffusion, and are low in overall cost. The reflectors are commonly of metal or masonite with plastic resin coatings. The significance of plastics in this use is their ability to retain surface appearance for a long period without deterioration. Glass and wool insulation is commonly bonded with a plastic resin to help it retain its shape. Plastic window screens and blinds are in use. The screens do not have to be painted. Rain water running off them will not stain the walls, and because of their transparency they do not seem to impair vision. Venetian blind slats of plastic are lighter than wood. They do not warp, and interesting translucent light transmission is possible.

Plastic dividing strips for terrazzo flooring are widely used. They are colorful, economical and easily bent to provide interesting

floor patterns.

There are other application of plastics than those in the building industry which are of interest to Civil Engineers.

Safety devices utilize plastics extensively in such applications as goggles, face shields, respirators, and helmets. Lightweight, toughness, and durability are three reasons for this use. Plastic coated cloth provides light weight, water resistant, and wind proof garments making it more comfortable for the man who works outdoors in adverse weather.

Laminated gears and bearings of phenolic impregnated canvas are practical applications of plastics. The gears are light in weight, noiseless, and provide longer life than metal in many cases. The advantage of the bearings is that they are water lubricated, they have good resilience, and a high degree of dimensional stability. The material is resistant to fresh and salt water, to oils and grease, and has long service life.

Plastics are used extensively in instruments such as your slide rule, calculators, triangles, railroad curves, transit, level and binoculars. Characteristics important here are low weight, durability, dimensional stability, and ease of being printed.

You gentlemen are undoubtedly more familiar with the advantages of this next application than I am. Reports indicate that the introduction of small quantities of vinsol resin into concrete for sea-going concrete barges improved workability and, by reducing the water content, increased density and strength. Also, vinsol resin is used in producing air entrained portland cements, which have excellent durability for pavement and highway construction as measured by resistance to freezing and thawing and to the application of common salt to provide safe travelling conditions over icy walks and roads.

Vinsol is also used for earth stabilization on airfields. The resin is spread in a manner similar to fertilizer and worked into the soil with a spiked roller and harrow. The resin imparts water resistance to the surface maintaining sufficiently hard surfaces for landing the heaviest planes in rainy weather.

In summarizing, I have tried to give you a general idea of what plastics are, in what forms they are available and what some of their common properties are so that you may dispel any illusions you may have had regarding the materials. They have their ad-

vantages and their shortcomings just as any other engineering material. The plastics industry is now mature, but it is still experiencing growing pains, not the least of which result from improper application of the materials. If you or any of your associates at any time consider the use of plastic materials, avail yourselves of the knowledge and experience so freely and willingly provided by the industry members. For it is only through carefully studied requirements of each application that a proper selection can be made for a satisfactory and useful plastic application. And it is only from a succession of such applications that we can augment our knowledge to make information and data on plastics a more useful tool in the hands of engineers and designers.

Material References:—

“Everyday Plastics”, *Modern Plastics Magazine*.

“Plastics, The Story of An Industry”, Society of Plastics Industry.

“The Plastics Industry”, Plastic Materials Manufacturers Asso.

“Plastics”, American Association of School Administrators.

“Plastics in Building”, Pacific Plastics *Bulletin*.

BOSTON SOCIETY OF CIVIL ENGINEERS

715 TREMONT TEMPLE, BOSTON, MASS.

ORGANIZED JULY 3, 1848



ACTS OF INCORPORATION

AN ACT

TO INCORPORATE THE BOSTON SOCIETY OF CIVIL ENGINEERS

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

SECTION 1. George M. Dexter, Simeon Borden, William P. Parrott, their associates and successors, are hereby made a corporation by the name of "The Boston Society of Civil Engineers," for the purposes of promoting science and instruction in the department of Civil Engineering, with all the powers and privileges, and subject to all the duties, liabilities, and restrictions set forth in the forty-fourth chapter of the Revised Statutes.

SECTION 2. The said corporation may hold real and personal estate not exceeding in amount twenty thousand dollars, and the funds or property thereof shall not be used for any other purpose than those declared in the first section of this act.

[Approved by the Governor, April 24, 1851.]

GEORGE S. BOUTWELL.

AN ACT

TO AUTHORIZE THE BOSTON SOCIETY OF CIVIL ENGINEERS TO HOLD

ADDITIONAL REAL AND PERSONAL ESTATE

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by authority of the same, as follows:

SECTION 1. Section two of chapter sixty-nine of the acts of the year eighteen hundred and fifty-one is hereby amended by striking out the word "twenty," in the second line, and inserting in place thereof the words, "two hundred" so as to read as follows: SECTION 2. The said corporation may hold real and personal estate, not exceeding in amount two hundred thousand dollars, and the funds or property thereof shall not be used for any other purpose than those declared in the first section of this act.

SECTION 2. This act shall take effect upon its passage.

[Approved by the Governor, March 12, 1902.]

W. MURRAY CRANE

CONSTITUTION AND BY-LAWS

PREAMBLE

The members of the Boston Society of Civil Engineers, in accordance with their charter and for the more effectual execution of the design of their institution, establish and ordain the following Constitution and By-Laws for the government of said Society.

CONSTITUTION

ADOPTED JUNE 15, 1910*

ARTICLE I—OBJECTS

The objects of this Society are: the professional improvement of its members, the encouragement of social intercourse among engineers and men of practical science, and the advancement of engineering. For the promotion of these objects, stated meetings of the Society shall be held and a library maintained for the use of its members.

ARTICLE II—MEMBERSHIP

The Society shall consist of Members, Honorary Members, Juniors, Students and Associates.

Members shall be civil, mechanical, mining or electrical engineers, or other persons belonging to a technical profession, not less than twenty-four years of age, who have been in the active practice of their profession for at least four years. Graduation from a school of engineering of recognized standing shall be considered as equivalent to two years of active practice.

Honorary Members shall be men of eminent scientific attainments whom the Society shall deem worthy of the distinction. They shall be subject to the payment of no fees, dues or assessments.

Juniors shall be not less than twenty years nor more than twenty-eight years of age, and their connection with the Society shall cease when they become twenty-eight years of age, unless they be previously transferred to another grade. They shall be in active practice in some branch of engineering, or other technical profession, or graduates from a school of engineering of recognized standing. Students shall be students in a school of engineering of recognized standing. Their membership shall cease at the annual meeting following the severance of their connection as students, unless they shall have transferred to another grade of membership.

Other persons interested in the objects of the Society and desirous of being connected with it shall be eligible as Associates.

The members of all grades shall be entitled to all privileges of the Society except the right to vote and to hold office, which rights shall be vested in the grade of Member alone; provided, however, that such Members as may be elected Honorary Members shall retain the right to vote and to hold office.

*Amended May 18, 1932, in Article II

Amended Feb 19, 1936, in Article II

Amended Feb 17, 1943, in Article III.

ARTICLE III—OFFICERS

The officers of the Society shall consist of a President, two Vice-Presidents, a Secretary, a Treasurer and four Directors. They shall be elected by letter-ballot at the Annual Meeting; shall assume their duties at the close of said meeting, and shall hold office until their successors are duly chosen. The President, Secretary and Treasurer shall be elected for one year; the Vice-Presidents and Directors for two years, one Vice-President and two Directors being elected each year.

The officers with the three latest Past Presidents who continue to be Members of the Society shall constitute the Board of Government, which shall have general management of the affairs of the Society.

In case of a vacancy in the office of President the senior Vice-President or the junior Vice-President shall succeed to the office in the order stated. In case of a failure in the succession, the latest Past-President who is a Member of the Society and willing to serve shall act as President.

In the case of a vacancy in the office of Secretary or Treasurer, the Board of Government may fill the office for the unexpired term.

In case of a vacancy in another office, provisions shall be made at the time of the Annual Election so that all offices shall then be filled.

ARTICLE IV—MEETINGS—QUORUM

Meetings of the Society shall be held at such times as may be prescribed by the By-Laws.

The regular meeting in March shall be the Annual Meeting for the election of officers and for the hearing of the annual reports.

Twenty-five members shall constitute a quorum for the transaction of business.

ARTICLE V—AMENDMENTS—ENDORSEMENTS

Proposed amendments to this Constitution shall be first submitted in writing to the Secretary, endorsed by at least five Members of the Society. The Board of Government shall designate some subsequent regular meeting, not later than four months from the date of the receipt of the petition, for discussion or amendment of the proposed amendment and shall so signify in the notice for said meeting. This notice shall contain a copy of the proposed amendment. If the proposed amendment, in its original or amended form, shall be adopted by a majority of the Members present and voting, it shall be forthwith submitted as adopted, in the form of a letter-ballot, to the Members for final action. The letter-ballot shall be accompanied by a notice of the date of the meeting at which the ballot will be canvassed, which date shall be not less than three weeks later than the date of its issue. An affirmative vote of two-thirds of all ballots cast shall be necessary to the adoption of any amendment.

No proposition which includes the Society's endorsement shall be passed except in the same manner as prescribed for amendments to the Constitution.

BY-LAWS

ADOPTED JUNE 15, 1910*

1. **Meetings.**—Regular meetings of the Society shall be held on the fourth Wednesday in January and September and on the third Wednesday of the other months, excepting July and August, unless otherwise authorized by the Board of Government.

2. **Order of Business.**—The following order of business shall be observed at all regular meetings unless set aside by a vote of members present:—

(1) Reading of the record of the previous meeting.

(2) Business and reports of committees.

(3) Literary exercises, to begin not more than a half-hour after the meeting is called to order.

(4) Unfinished business.

3. **Special Meetings.**—The President may call meetings of the Society when he deems it expedient, and shall do so at the written request of ten Members, stating the purpose of such meeting. No business shall be transacted at a special meeting except that stated in the notice thereof.

4. **Expiration of Committees.**—At the Annual Meeting all special committees shall expire unless continued by a vote of the Society.

5. **Nominating Committee and Election of Officers.**—Whenever officers of the Society are to be elected by ballot, nominations shall be made by a Nominating Committee of nine, of whom three shall be the three latest Past Presidents who continue to be members of the Society and are not members of the Board of Government, and six shall be elected by ballot. Three members of the Nominating Committee shall be elected at each annual meeting to serve two years each.

The Nominating Committee shall organize and act under its own rules. It may make nominations whether at the time it consists of nine members or of less, but the approval of at least two-thirds of the members of the Nominating Committee shall be required for a nomination.

The Nominating Committee shall prepare a list of its nominations for the officers to be elected at the annual election, and the Secretary shall mail this list to each member of the Society at least nine weeks before the annual meeting. An additional nomination for any office may be made by any twenty-five members of the Society who sign a nomination paper to that effect and file it with the Secretary at least six weeks before the date of the annual meeting. The Secretary shall print no nomination on any list or ballot until he has received notice in writing that the nomination is made with the knowledge and consent of the nominee. At least four weeks before the day of the annual meeting, letter-ballots shall be sent by the Secretary to each member of the Society, bearing the nominations made by the Nominating Committee, and also any which have been received on nomination papers as above provided, which latter nominations shall be distinguished in some convenient way from those made by the Nominating Committee. The ballot shall state the hour at which polls will close on the day of the annual meeting.

When returned to the Secretary, each ballot shall be enclosed in two envelopes,

*Amended March 19, 1913; Jan. 28, 1914; Dec. 19, 1917; June 15, 1921; Feb. 21, 1923; Nov. 18, 1925; Jan. 20, 1927; Oct. 17, 1928; Sept. 24, 1930; May 18, 1932; Feb. 19, 1936; Dec. 20, 1939; Jan. 8, 1941; Feb. 17, 1943; and Dec. 16, 1943

the inner one to be blank, and the outer one to be endorsed by the member's signature. The President shall appoint two tellers who shall canvass all ballots, and the result shall be announced at the annual meeting.

Of the candidates for any office at the election at the annual meeting, the one having the largest number of legal votes by letter-ballot shall be elected. Should there be a failure to elect any officer on account of a tie, the meeting shall proceed to elect such officer by ballot from among the candidates so tied, a majority of the votes cast being required to elect.

Whenever a President, Vice-President, Director, Secretary or Treasurer is to be elected, the Nominating Committee shall nominate one candidate for each office to be filled. Whenever a member of the Nominating Committee is to be elected, the Nominating Committee shall nominate two candidates for each office which is to be filled. Ballots shall provide space for the writing or pasting in of additional names by the voters.

The Nominating Committee shall, at the time of the Annual Election, make nominations to fill vacancies in any office or in the Nominating Committee.

6. Duties of Officers.—The President shall have general supervision of the affairs of the Society. He shall preside at all meetings of the Society and of the Board of Government at which he may be present. He shall deliver an address at the Annual Meeting.

The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President.

The Secretary, under the direction of the President and Board of Government, shall be the executive officer of the Society. He shall keep records of all meetings of the Society and of the Board of Government; shall receive all fees, dues and other moneys due the Society (except the income on the permanent fund) and transmit the same monthly to the Treasurer.

The Treasurer, under the direction of the President and Board of Government, shall be charged with the custody and investment of all funds of the Society, and shall file annually an approved surety bond in an amount to be determined by the Board of Government, the premium on said bond to be paid from the Society's funds. He shall receive all funds transmitted to the Secretary and shall pay all bills or other indebtedness of the Society when properly approved by the President. He shall keep an accurate record of all receipts and disbursements and of all property of the Society in his charge and shall render a report of same at the Annual Meeting.

A committee consisting of two Directors, to be appointed by the President, shall audit the accounts of the Secretary and Treasurer.

The Board of Government shall have general management of the affairs of the Society in conformity with the Constitution and By-Laws. It shall hold stated meetings at least once in every month, excepting July and August, and at such other times as it may determine or when called by the President. Five members shall constitute a quorum for the transaction of business. The Board of Government shall direct the investment and care of the funds of the Society; shall order all ordinary or current expenditures; shall fix the salaries of the Secretary, Treasurer and Librarian; shall provide for the exercises at the meetings; shall act upon applications for membership as hereinafter provided; shall examine all papers submitted with reference to their fitness for presentation to the Society and for publication, and shall report at each Annual Meeting. To perform these duties it may make such rules and regulations, within its powers, as it may deem

necessary; and may appoint committees from its members and delegate to them such of its powers as it may deem expedient, provided, however, that any action of a committee unfavorable to any member shall be reported to the whole Board for final action. The Board of Government shall appoint from its members, or from the members of the Society at large, a Committee on Publication, which shall have charge of the publication of all papers and transactions of the Society.

The Board of Government shall elect each year a member of the Society as Librarian, who shall have the general supervision of the Society's library, shall make recommendations to the Board of Government relating thereto, and shall, under its direction, expend such sums as may be appropriated for the library.

7. Election of Members.—Honorary Members shall be proposed by at least ten Members and shall be elected by a unanimous vote of the Board of Government. A person elected an Honorary Member shall be promptly notified thereof by letter. The election shall be cancelled if an acceptance is not received within six months after the mailing of such notice.

An application for admission to the Society as a Member, Junior or Associate, or for transfer from one grade to another, shall contain over the candidate's signature, a statement of his age, residence and qualifications for membership, and a promise that he will conform to the requirements of membership, if elected. The applicant shall furnish the names of at least four members to whom he is personally known. Each of these shall be requested by the Secretary to address a letter to the Board of Government, on a form prescribed by said Board, stating the extent of the writer's personal knowledge of the applicant and of his professional work. If less than four of the members named as references furnish the requisite information the Secretary shall call upon the applicant for additional names, and not until written communications shall have been received from at least four members shall the application be considered by the Board. Applicants who may be so situated as not to be personally known to four members may be recommended by three members of the Board of Government.

Each application for admission or for transfer shall be announced in the JOURNAL, accompanied by a concise statement of the record of each applicant and the names of his references, together with a request that members transmit to the Board any information in their possession which may be of assistance in the consideration of the application. Not less than fifteen days after said announcement, the Board of Government shall consider the application together with any information in regard to the applicant that may have been received; shall classify the applicant with his consent and shall vote thereon. The votes of at least two-thirds of the members of the Board of Government shall be cast to constitute an election, these votes to be cast by letter-ballot if necessary. Two or more negative votes shall exclude from election.

Each elected candidate shall be duly notified and shall subscribe to the Constitution and By-Laws and pay his entrance fee. If these provisions are not complied with within two months from the notification of the election, such election shall be void unless, for special reasons, the time shall be extended by the Board of Government. Membership of any person shall date from the day of his election.

A rejected applicant may renew his application for membership or transfer at any time after the expiration of one year from the date of the ballot rejecting his previous application.

An applicant for Student Membership shall submit a statement that he is a bona fide student in the Institution which he is attending. This statement shall

be signed by the Dean, Registrar or other officer of the Institution acceptable to the Board of Government.

8. Fees and Dues.—The entrance fee for Members and Associates shall be ten dollars; for Juniors, five dollars; and for Students, three dollars; except that for commissioned officers in the armed forces of the United States and for employees of other permanent agencies of the Federal Government the entrance fee shall be waived. The entrance fee for Students shall be submitted with the application. There shall be no fee for transfer to a higher grade. Five dollars of the first year's dues of a Member after transfer from the Grade of Junior shall go to the permanent fund; two dollars of the first year's dues of a Junior after transfer from the grade of Student shall go to the permanent fund. The annual dues, payable in advance at the Annual Meeting, shall be as follows: by Resident Members and Associates, ten dollars; by Non-Resident Members and Associates, six dollars; by Resident Juniors, five dollars; by Non-Resident Juniors, four dollars; and by Students, three dollars. There shall be no dues for Students for the period between their date of election and the next Annual Meeting. The members of any grade, except that of Student, residing within thirty miles of Boston shall be considered as Resident, and those beyond that limit as Non-Resident. New members other than Students elected during the period from the close of the annual meeting to June inclusive shall pay full year's dues; members elected during the period from July to December inclusive shall pay one-half year's dues for that fiscal year; members elected during the period from January to the annual meeting inclusive shall be exempt from dues during the remainder of that fiscal year. The fiscal year shall commence at the close of the annual meeting.

Three dollars of the dues of each member, or such portion thereof as may be required, shall annually be applied to the payment of a subscription to the *JOURNAL of the Boston Society of Civil Engineers*.

The Board of Government may for such reasons as it may deem sufficient remit the dues in any current year of any member whom it may find to be unable to pay the same, no record to be made of the name of such member, but the number of such cases shall be reported to the Society annually.

A member of any grade who has paid dues for forty years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues.

9. Permanent Fund.—There shall be a fund called the Permanent Fund, to which shall be added all money received for entrance fees and all income from investments of the fund. In any fiscal year of the Society the income from the Permanent Fund, may upon vote of the Board of Government, be transferred to the current fund for the payment of current expenses to the extent necessary to maintain the current fund. No other sum shall be appropriated from the Permanent Fund except by a two-thirds vote at two successive regular meetings of the Society; and any such appropriation or any part thereof not used within three years shall be returned to the fund.

10. Resignation of Membership.—Any person whose indebtedness to the Society has been fully paid may withdraw from membership by notifying the Secretary. Any person so resigning his membership may, at the discretion of the Board of Government, be reinstated without again paying the entrance fee.

11. Forfeiture of Membership.—Ten months after the Annual Meeting, the Secretary shall notify each member who has not paid his dues for the current

year, that unless same are paid within thirty days, his membership in the Society shall cease. Unless said payment is so made his name shall be dropped from the list of members. The Board of Government may, however, at its discretion reinstate such person on the payment of all arrears.

12. Expulsion of Members.—Upon the written request of five Members, that, for cause stated, any member be expelled, the Board of Government shall consider the matter, and if it deems it best, shall advise the member that his resignation will be accepted. He shall, however, have the right to demand and receive a copy of the charges against him, and shall have reasonable time to prepare a written defence. The Board of Government may then pass finally upon the matter; and if the resignation has not been tendered, or a satisfactory defence made, may, by an affirmative vote of nine of its number, expel the member, in which case he shall be notified, and his name shall at once be dropped from the list of members.

13. Sections.—The Board of Government may from time to time at its discretion, establish sections for the consideration of special branches of engineering. Such sections shall in all cases be known as "The [name] Section of the Boston Society of Civil Engineers," and shall consist of not less than ten members of the Society.

Unless a section is in active operation within three months from the date of its establishment, the authorization for its formation shall be void.

Members of the Sanitary Section who are not members of the Society at the time of the adoption of these By-Laws, may continue their present membership by the annual payment of six dollars for dues; they may be transferred to membership in the Society in the same manner and by the payment of the same fee as provided for the transfer of Juniors. This paragraph shall be void when the list of members to which it applies has been exhausted.

Papers read before sections and discussions thereon may be reported in accordance with the section by-laws, and shall be published in the same manner and subject to the same conditions as obtain with respect to papers read before the Society.

All sections shall be governed by the Constitution and By-Laws of the Society, so far as applicable, but they shall be entitled to make additional by-laws for their own use and government: *provided, however*, that said additional by-laws be not inconsistent with the Constitution and By-Laws of the Society, and that they be approved by the Board of Government.

The officers of each section shall be a Chairman, Vice-Chairman and Clerk, who shall be elected by the members of the section annually.

The general government of each section shall be vested in an Executive Committee, consisting of the President of the Society, the officers of the section, and three additional members of the section who shall be elected annually.

The officers of sections may expend such sums for the expenses of meetings as may be appropriated by the Board of Government.

The Chairman of sections shall be entitled to be present at the meetings of the Board of Government, but shall have no vote.

Any section may be abolished by the Society by a two-thirds vote of all the Members present at any regular meeting, upon recommendation of the Board of Government, due notice of such recommendation having been sent with the notice of the meeting to each Member of the Society, and to each member of the section

in question who is not a member of the Society, and all members of the section in question shall be entitled to be heard at this meeting.

Resignations, forfeiture of membership, or expulsion of members of sections shall be governed by the same conditions and methods of procedure as apply to members of the Society.

14. Affiliate Sections.—The Board of Government may, from time to time, at its discretion, establish Affiliate Sections which shall be duly organized sections of kindred societies whose objects are in harmony with those of this Society. The requirements governing such Affiliate Sections shall be those governing Sections, as provided for under these By-Laws so far as applicable, with such modification as may be approved by the Board of Government as necessary to effect suitable working arrangements, having due regard to the interests of this Society.

15. An amendment to the By-Laws may be made by a two-thirds vote of the Members present and voting, cast in favor of such amendment at each of two successive regular meetings, due notice of the proposed amendment having been sent to each Member with the notices of the meetings.

APRIL 8, 1946.

BY-LAWS OF THE SECTIONS of the BOSTON SOCIETY OF CIVIL ENGINEERS

Sections Organized

Sanitary Section	January 27, 1904
Designers Section	May 19, 1920
Transportation Section*	May 1, 1924
Hydraulics Section	May 1, 1940
Northeastern University Section	January 20, 1922

Adopted by the Sanitary Section, Designers Section, Northeastern University Section, Transportation Section, and Hydraulics Section.†

(Approved by the Board of Government March 21, 1934)

(Amended April 8, 1946)

ARTICLE I—OBJECTS

SECTION 1. The objects of the Section shall be the advancement of knowledge relating to the science and practice of engineering, the professional improvement of its members, the encouragement of the presentation of papers and informal discussion of engineering topics, and the opportunity for social intercourse among its members.

ARTICLE II—MEMBERSHIP

SECTION 1. Members of the Boston Society of Civil Engineers in all grades shall be entitled to membership in the Section upon making written application to the Executive Committee of the Section, except as follows: Membership in the Northeastern University Section is limited to members of the Society in all grades, who are students, graduates or members of the Faculty of Northeastern University.

SECTION 2. Eligibility to office and the right to vote shall be limited to the membership of the Section, except as follows: Only those members of the Northeastern University Section who are students at Northeastern University are eligible to hold office in that section.

SECTION 3. Members of the Society in all grades, who are not enrolled as members of the Section, shall be entitled to attend all meetings of the Section and take part in the discussion of professional subjects, but shall have no vote.

ARTICLE III—OFFICERS

SECTION 1. The officers of the Section shall be a Chairman, Vice-Chairman and Clerk. The general government of the Section shall be vested in an Executive Committee, consisting of the President of the Boston Society of Civil Engineers, the Chairman, Vice-Chairman, Clerk and three other members of the Section.

SECTION 2. The Chairman of the Section shall represent the Section at the meetings of the Board of Government of the Boston Society of Civil Engineers, with the privilege accorded under its By-Laws.

*Originally established in 1924 as Highway Section, re-named Transportation Section April 8, 1946.

SECTION 3. The term of office of all officers and committees shall be one year, but shall continue until their successors are elected.

SECTION 4. All officers and committees shall assume their duties immediately after the close of the meeting at which they have been elected.

SECTION 5. Vacancies occurring in any office may be filled by ballot at the first meeting after notice of the same has been sent to each member, a majority of the votes cast being necessary to elect.

ARTICLE IV—MANAGEMENT

SECTION 1. The Chairman shall have general supervision of the affairs of the Section. He shall preside at meetings of the Section. In case of his absence or a vacancy in his office, the Vice-Chairman shall discharge his duties.

SECTION 2. The Executive Committee shall have control of the management of the Section, subject to the action of the Section at any meeting, and shall make the necessary arrangements for all meetings. All questions in Executive Committee shall be decided by a majority vote, and four members shall constitute a quorum. Meetings of the Executive Committee shall be held at the call of the Chairman, or, in his absence or inability to serve, at the call of the Vice-Chairman.

SECTION 3. The Clerk shall keep the records of the meetings of the Section and of the Executive Committee, and perform such other duties as are herein prescribed and as may be required by the Executive Committee. He shall prepare and transmit to the Secretary of the Boston Society of Civil Engineers notices of all meetings, copies of the records of all meetings and of all papers and discussions.

SECTION 4. No expenditure shall be made or financial obligation incurred by any officer or committee of the Section, for which the Society will be responsible, without previous authorization by the Board of Government or President of the Society.

ARTICLE V—MEETINGS

SECTION 1. The annual meeting of the Section, at which the annual reports for the preceding year shall be presented and the officers for the ensuing year elected, shall be held as follows:

Sanitary Section.—First Wednesday in March.

Designers Section.—Second Wednesday in March.

Transportation Section.—Fourth Wednesday in February.

Hydraulics Section.—First Wednesday in February.

Northeastern University Section.—Fourth Thursday of the last five-week period of the spring term.

SECTION 2. The officers and other members of the Executive Committee shall be elected at this meeting by written ballot. A Nominating Committee of three members, which shall be elected at a meeting in advance of the Annual Meeting, shall present a list of nominees for officers and other members of the Executive Committee at the Annual Meeting. Additional nominations may be made from the floor.

SECTION 3. The regular meetings of the Section shall be held as follows, unless otherwise authorized by the Executive Committee:

Sanitary Section.—First Wednesday of the months of March, June, October and December.

Designers Section.—Second Wednesday of the months of October to May, inclusive.

Transportation Section.—Third Wednesday in September; fourth Wednesday of the months of November, February and April.

Hydraulics Section.—First Wednesday in February, other meetings first Wednesday in May and November.

Northeastern University Section.—Fourth Thursday of every five-week school period.

SECTION 4. Special meetings of the Section shall be held at the call of the Chairman. At special meetings no business shall be transacted, unless announced in the call for the meeting and upon recommendation of the Executive Committee.

SECTION 5. Ten members shall constitute a quorum for the transaction of business.

ARTICLE VI—AMENDMENTS

SECTION 1. Proposed amendments to these By-Laws must be submitted in writing to the Executive Committee, and shall be presented to the Section at a regular meeting, if so decided by vote of the Executive Committee. The Executive Committee shall, however, bring before the Section any proposed amendment at the written request of ten members.

SECTION 2. Announcement of a proposed amendment which is recommended by the Executive Committee or by ten members of the Section shall be given by printing the amendment in the notice of the regular meeting. A two-thirds vote of the members present and voting shall be necessary for the adoption of the amendment.

SECTION 3. All amendments to these By-Laws must receive the approval of the Board of Government of the Boston Society of Civil Engineers before taking effect.

PRIZES AWARDED BY BOSTON SOCIETY OF CIVIL ENGINEERS

DESMOND FITZGERALD MEDAL

The Desmond FitzGerald medal, an endowed prize, is awarded for papers presented at meetings of the Boston Society of Civil Engineers and published in the JOURNAL of the Society. This prize is to be awarded annually unless the Board of Government shall decide that none of the papers presented during the year are of such a character as to merit the award.

With the assent and approval of the donor, the Society has assumed the responsibility for the payment in perpetuity of the Desmond FitzGerald medal.

Rules Governing the Award of the Desmond FitzGerald Medal

COMMITTEE ON AWARD

1. The Board of Government shall appoint annually, not later than its regular meeting in June of each year, three members of the Society, not members of the Board of Government, who shall form a committee to recommend the award of the prize.

2. The papers considered shall include all papers published by the Society during the year ending with the month of October.

3. The Committee on Award shall report its recommendation to the Board of Government at its February meeting, and the awards shall be made by the Board of Government.

4. The announcement of the awards shall be made at the annual meeting.

5. The Secretary of the Society shall act as Secretary to the Committee on Award, but shall have no vote or voice in its deliberations.

CODE OF RULES

THE DESMOND FITZGERALD MEDAL.—This medal was instituted and endowed in 1910 by Desmond FitzGerald, member and Past President of the Boston Society of Civil Engineers.

I. Competition for the medal of the Boston Society of Civil Engineers shall be restricted to members of the Society of all grades.

II. There shall be one bronze medal awarded as hereinafter provided. The dies therefor shall be deposited with the superintendent of the United States Mint at Philadelphia, in trust exclusively for the above purpose.

III. All original papers presented to the Society by members of any class, and published by the Society during the year for which the medal is awarded, shall be open to the award, provided that such papers shall not have been previously contributed in whole or in part to any other association, nor have appeared in print prior to their publication by the Society.

IV. The medal shall be awarded for a paper which shall be judged worthy of special commendation for its merit.

SECTION PRIZE AWARDS

Rules Governing Section Awards for Sanitary, Designers, Transportation, and Hydraulics Sections

The Board of Government of the Boston Society of Civil Engineers voted on April 12, 1924, "to present a prize for a worthy paper given in each section

by a member of that Section." the awards to be made under the following rules:

1. The Board of Government shall award annually in each section a prize for the best paper presented during the year, provided that paper is judged worthy of special commendation.

2. The Board shall appoint annually a Committee on Award for each section, to be composed of three members, one of whom shall be a member of the Committee on Award of the Desmond FitzGerald medal, the others shall be members of the particular section involved, and none shall be members of the Board of Government. The appointment shall be made not later than at its regular meeting in June. The Committee on Award shall recommend to the Board their selection of successful papers.

3. The papers considered shall include all original papers which are submitted in form suitable for publication, by members in all grades of the respective sections, and shall have been accepted by the Executive Committee of the Section or its approved agent, either for publication or for presentation at a meeting. All papers considered shall be presented at a meeting or published during the year ending with the month of October, and no paper shall be eligible which has received, or is to receive, any other award of the Society, or which has previously been contributed to any other association, or has appeared in print prior to its presentation to the section.

4. The Committee on Award shall report their recommendations to the Board of Government at its February meeting, and the awards shall be made by the Board of Government.

5. The announcement of the awards shall be made at the annual meeting.

6. The award shall consist of a book or books of a value not exceeding fifteen dollars, and shall be suitably inscribed on the flyleaf with the name of the recipient, the name and date of presentation of the paper, and the name of the section, together with the fact that it was judged the most worthy paper presented in that section during that particular year. The inscription shall be in handwriting attested to by the President of the Society and the chairman of the Section. The Committee on Award shall select the book or books to be awarded, but may consult with the recipient as to his particular desires in the matter.

Rules Governing Prize Awards for Northeastern University Section

The Board of Government voted on March 10, 1931, to revise the Rules Governing the Award of Section Prizes in order to provide specifically for the award of a prize to a member of the Northeastern University Section.

1. The Board of Government of the Boston Society of Civil Engineers shall award annually in the Northeastern University Section a prize for an original paper prepared by a member of the Section and presented by the author during the year at a regular Engineering Conference meeting.

2. A committee of the faculty at Northeastern University shall present to the Committee on Award of the Boston Society of Civil Engineers two papers selected by the University at such a time as may be required.

3. The Committee on Award shall report its recommendation to the Board of Government at its February meeting, and the awards shall be made by the Board of Government.

4. The announcement of the awards shall be made at the annual meeting of the Boston Society of Civil Engineers.

5. The award shall consist of a book or books of a value not exceeding fifteen dollars; these shall be suitably inscribed with the name of the recipient, the name and date of publication of the paper, and the name of the Section, together with the fact that it was judged a paper worthy of special commendation. The inscription shall be signed by the President of the Society and the chairman of the Section. The Committee on Award shall select the book or books to be awarded, but may consult with the recipient as to his particular desires in the matter.

6. The winning paper may or may not be printed in the JOURNAL of the Boston Society of Civil Engineers at the discretion of the Publication Committee.

CLEMENS HERSCHEL AWARDS

In 1923 the late Clemens Herschel, a Past President and an honorary member of the Boston Society of Civil Engineers, presented to the Society a number of autographed copies of his book, entitled "Frontinus and the Water Supply of the City of Rome," with the request that the Board of Government should award one or more of these books as prizes for papers which have been particularly useful and commendable and worthy of grateful acknowledgment. These copies were exhausted in 1941; but the Clemens Herschel fund established in 1931 as a bequest, now provides for prizes of equivalent purpose.

LIST OF PRIZES AND SCHOLARSHIPS Awarded by BOSTON SOCIETY OF CIVIL ENGINEERS

DESMOND FITZGERALD MEDAL

Instituted and endowed in 1910 by Desmond FitzGerald, member and Past President of the Boston Society of Civil Engineers, for an original paper presented by a member of the Society and published during the year, which is adjudged worthy of Special Commendation for its merit.

<i>Awarded at Annual Meeting</i>	<i>Author and Subject of Paper</i>
March 20, 1912—	Charles R. Gow. "Methods and Cost of Construction of the Slow Sand Purification Works for the New Springfield, Mass., Water Supply".
March 19, 1913—	Charles T. Main. "The Work, Aim and Conduct of the Engineer".
March 18, 1914—	David A. Hartwell. "The Fitchburg, Mass., Intercepting Sewer". Sanitary Section, Feb. 5, 1913.
March 17, 1915—	Joseph R. Worcester. "Boston Foundations". Society, January 28, 1914. January, 1914, JOURNAL.
March 15, 1916—	William S. Johnson. "Ground Water Supplies". Society, Feb. 17, 1915. May, 1915, JOURNAL.
March 21, 1917—	Dana M. Wood. "Power Estimates from Stream Flow and Rainfall Data". March, 1916, JOURNAL, March, 1916. (not presented).
March 20, 1918—	None.
March 19, 1919—	Stephen DeM. Gage. "The Sanitary Control of Swimming Pools". Sanitary Section. Dec. 5, 1917. June, 1918, JOURNAL.
March 17, 1920—	Edgar S. Dorr & Robert Spurr Weston. "Disposal of Sewage by Treatment with Acid". Society, January 22, 1919; April, 1919, JOURNAL.
March 16, 1921—	Harrison P. Eddy. "Maximum Rates of Precipitation at Boston for Various Frequencies of Occurrence". Feb., 1920, JOURNAL. (not presented).
March 15, 1922—	Harold K. Barrows. "Water Power Development in New England". Society, December 17, 1920. Jan., 1921, JOURNAL.
March 21, 1923—	None.
March 19, 1924—	Arthur T. Safford. "The Amoskeag Manufacturing Company Hydro-Electric Development". Society, January 24, 1923; March, 1923, JOURNAL.
March 25, 1925—	Arthur C. Eaton. "The New England Power Company-Davis Bridge Development". Society, December 17, 1924; January, 1925, JOURNAL.

- March 17, 1926—Frank C. Shepherd. "The Preservative Treatment of Ties on the Boston & Maine Railroad". March, 1925, JOURNAL.
- March 16, 1927—Harry A. Hageman and Theodore B. Parker. "The Bartlett's Ferry Hydro-Electric Development". Society, February 17, 1926; March, 1926, JOURNAL.
- March 21, 1928—Dr. Charles Terzaghi. "Concrete Roads—A Problem in Foundation Engineering". Highway Section, February 23, 1927; May, 1927, JOURNAL.
- March 20, 1929—None.
- March 19, 1930—James W. Rollins. "Pier Construction for the Mid-Hudson Bridge at Poughkeepsie, N. Y.". Society, May 15, 1929; October, 1929, JOURNAL.
- March 18, 1931—H. B. Kinnison. "Stream Flow Data—Its Collection and Uses". Society, April 16, 1930; May, 1930, JOURNAL.
- March 16, 1932—H. K. Fairbanks. "Wyman Dam and Hydro-Electric Power Development at Bingham, Maine". Society, Nov. 19, 1931; Dec. 1931, JOURNAL.
- March 15, 1933—Clarence R. Bliss. "Fifteen Mile Falls Lower Development". Society, May 20, 1932; September, 1932, JOURNAL.
- March 21, 1934—Albert E. Kleinert. "The Design and Construction of the French King Bridges on the Mohawk Trail Route across the Connecticut River, Massachusetts". Society, April 18, 1933; June, 1933, JOURNAL.
- March 20, 1935—Glennon Gilboy. "Mechanics of Hydraulic-Fill Dams". Society, May 16, 1934; July, 1934, JOURNAL.
- March 18, 1936—Arthur Casagrande. "Characteristics of Cohesionless Soils Affecting the Stability of Slopes and Earth Fills". Joint Meeting, Nov. 13, 1935; January, 1936, JOURNAL.
- March 17, 1937—Albert Haertlein. "The Design of Statically Indeterminate Trusses". Designers Section, January 8, 1926; April, 1936, JOURNAL.
- March 16, 1938—Donald W. Taylor. "Stability of Earth Slopes". Joint Meeting, November 23, 1937; July, 1937, JOURNAL.
- March 15, 1939—Arthur D. Weston. "The Charles River Basin". Society, March 16, 1938; October, 1938, JOURNAL.
- March 20, 1940—Howard A. Gray. "Enlargement of L. Street Steam-Electric Plant of Boston Edison Company". Society, January 25, 1939; April, 1939, JOURNAL.
- March 19, 1941—Harrison P. Eddy, Jr. and Almon L. Fales. "Discussion of Problems of Sewerage & Sewage Disposal in Metropolitan Boston". Joint Meeting, January 24, 1940; April, 1940, JOURNAL.
- March 18, 1942—Howard M. Turner and Allen J. Burdoin. "The Flood Hydrographs". Hydraulics Section, May 7, 1941; July, 1941, JOURNAL.
- March 17, 1943—John B. Wilbur. "The Smith-Putnam Wind Turbine Project". Society, March 18, 1942; July, 1942, JOURNAL.
- March 22, 1944—Ralph W. Horne. "Cranston Rhode Island Builds Complete New Sewerage Works for 53,000 People". Joint Meeting, January 27, 1943; April, 1943, JOURNAL.
- March 21, 1945—Scott Keith. "Hydraulics of the Park River Conduit, Hartford, Conn.". Hydraulics Section, May 3, 1944; July, 1944, JOURNAL.

March 20, 1946—Prof. Albert G. H. Dietz. "Details of Design with Timber Connectors". Designers Section, October 13, 1943; January, 1945, JOURNAL.

CLEMENS HERSCHEL AWARD

The late Clemens Herschel, a former Past President and Honorary Member of the Society, had assigned to the Society in 1921 a number of autographed copies of his book on "Frontinus and the Water Supply of the City of Rome", with the request that the Board of Government award one or more of these books each year as prizes for papers which have been particularly useful and commendable, and worthy of grateful acknowledgment. In 1931 the Society received a Clemens Herschel bequest amounting to \$1000, the income of which is to be used for the same purpose. The prize consists of books, suitably inscribed.

Awarded at

Annual Meeting

Author and Subject of Paper

- March 15, 1922—Charles R. Gow. "The Responsibility of Organized Labor for the Stagnation in the Building Industry". Society, March 24, 1921; April, 1921, JOURNAL.
- March 21, 1923—(a) Arthur T. Safford for his work as Chairman of the Run-Off Committee, the report of which was printed in October, 1922, JOURNAL.
(b) George H. Nye. "What shall be done to secure better City Planning?" Society, May 17, 1922; June, 1922, JOURNAL.
- March 19, 1924—(a) John W. Raymond, Jr. "Some Features of Sewer Design". Designers Section, April 12, 1922; January, 1923, JOURNAL.
(b) J. Stuart Crandall. "Floating Dry Dock Design". Designers Section, March 12, 1923; September, 1923, JOURNAL.
- March 25, 1925—(a) Almon L. Fales. "Odor Elimination". Sanitary Section, February 6, 1924; April, 1924, JOURNAL.
(b) Charles H. Pierce. "Flood Flows of New England Rivers". Not presented, but printed in October, 1924, JOURNAL.
- March 17, 1926—(a) Edward P. Hamilton. "The Development of the Science of Hydraulics". Not presented, but printed in October, 1925, JOURNAL.
(b) Dr. Charles Terzaghi. "Modern Conception Concerning Foundation Engineering". Society, November 18, 1925; Dec., 1925, JOURNAL.
- March 16, 1927—(a) Earle B. Phelps. "Chlorination of Water and Sewage". Sanitary Section, February 3, 1926; April, 1926, JOURNAL.
(b) Albert J. Houston. "Some Observations on European Water Power Practice". Society, September 22, 1926; October, 1926, JOURNAL.
(c) D. B. Steinman and W. G. Grove. "Design and Construction of Florianopolis Bridge". Society (Joint), October 20, 1926; November, 1926, JOURNAL.
- March 21, 1928—(a) Charles M. Allen. "Water". Annual, March 16, 1927; April, 1927, JOURNAL.
(b) Dr. Geo. H. deTheirry. "Application of Laboratory Re-

- search to the Study of Hydraulic Problems". Society, April 28, 1927; January, 1928, JOURNAL.
- March 20, 1929—(a) Dr. William Rudolfs. "Sludge Digestion". Sanitary Section, December 5, 1928; January, 1929, JOURNAL.
 (b) Edward H. Cameron. "Engineering Features of a Modern Glass Bottle Plant". June, 1928, JOURNAL. (not presented).
- March 19, 1930—William F. Uhl. "The Development of the Mongaup River". Society, February 20, 1929; May, 1929, JOURNAL.
- March 18, 1931—(a) Edwin A. Dow. "Hydraulic and Mechanical Features of Bellows Falls Hydro-Electric Plant of the N. E. Power System". February 19, 1930 meeting; March, 1930, JOURNAL.
 (b) Alexander Gelman. "The Angular Rotation Method for the Analysis of Multiple Span Frames". Designers Section, February 12, 1931; December, 1930, JOURNAL.
- [BEQUEST OF \$1000 RECEIVED FROM CLEMENS HERSCHEL THIS YEAR]
- March 16, 1932—(a) Wm. H. Bassett. "Shrinkage of Concrete in Actual Structures". Designers Section, December 19, 1930; March, 1931, JOURNAL.
 (b) J. B. Belknap and C. I. Sterling. "Iron in the Ground-water Supplies of Massachusetts". Sanitary Section, December 2, 1931; January, 1932, JOURNAL.
- March 15, 1933—(a) Frank E. Winsor. "The Metropolitan District Water Supply Tunnel from the Ware River to the Wachusett Reservoir". Society, October 19, 1932; November, 1932, JOURNAL.
 (b) Arthur Casagrande. "The Structure of Clay and its Importance in Foundation Engineering". Designers Section, January 13, 1932; April, 1932, JOURNAL.
- March 21, 1934—Karl R. Kennison. "New Type of Open Flow Nozzle for Measurement of Sewage Flow". Sanitary Section, December 6, 1933; January, 1934, JOURNAL.
- March 20, 1935—Leo Jurgenson. "The Application of Theories of Elasticity and Plasticity to Foundation Problems". Designers Section, May 9, 1934; July, 1934, JOURNAL.
- March 13, 1936—Richard S. Holmgren. "Sewage Disposal Works, Bristol, R. I.". Sanitary Section, October 2, 1935; January, 1936, JOURNAL.
- March 17, 1937—No award.
- March 16, 1938—Charles M. Noble. "The Factor of Safety in Highway Design". Society, January 27, 1937; April, 1937, JOURNAL.
- March 15, 1939—Thaddeus Merriman. "Portland Cement". Society, October 19, 1938; January, 1939, JOURNAL.
- March 20, 1940—(a) Otis D. Fellows. "Highway of the Boston Metropolitan District—Their Origin and Evolution". Highway Section, April 26, 1939; July, 1939, JOURNAL.
 (b) Charles E. Greene. "Mechanical Equipment for Refuse Incinerators". Sanitary Section, March 1, 1939; July, 1939, JOURNAL.

- March 19, 1941*—(a) Miles N. Clair. "Concrete Technology". Society, April 17, 1940; July, 1940, JOURNAL.
 (b) Robert D. Chellis. "A Consideration of Pile Driving with Application of Pile Loading Formula". Designers Section, March 13, 1940; January, 1941, JOURNAL.
- March 19, 1942—None.
- March 17, 1943—Dr. Karl Terzaghi. "Shield Tunnels of the Chicago Subway". Society, May 20, 1942; July, 1942, JOURNAL.
- March 22, 1944—William C. White. "Engineering Education. Yesterday, Today and Tomorrow". Society, March 17, 1943; April, 1943, JOURNAL.
- March 21, 1945—(a) Howard M. Turner, "Domestic Rates and Consumption". Annual, March 22, 1944; April, 1944, JOURNAL.
 (b) Mr. A. C. W. Siecke. "Engineering Highlights of the 'Normandie' Salvage". Society, October 27, 1943; January, 1944, JOURNAL.
- March 20, 1946—Prof. Charles O. Baird, Jr. "Photogrammetry". Joint Meeting of Main Society and Highway Section, February 28, 1945; April, 1945, JOURNAL.

SECTION PRIZE AWARDS

The Board of Government voted on April 12, 1924, to present a prize for a worthy paper given in each section by a member of that section, "this award to consist of books suitably inscribed".

SANITARY SECTION

<i>Awarded at Annual Meeting</i>	<i>Author and Subject of Paper</i>
March 17, 1926	F. William Haley. "Recent Additions to the Sewerage System and Disposal Works of Framingham, Massachusetts". Sanitary Section, March 4, 1925; June, 1925, JOURNAL.
March 16, 1927	Gordon M. Fair. "Sludge Digestion—Reaction and Control". Sanitary Section, December 1, 1926; February, 1926, JOURNAL.
March 20, 1929	Frank A. Marston. "Progress in Sewage Treatment Abroad". Sanitary Section, December 7, 1927; June, 1928, JOURNAL.
March 19, 1930	Robert Spurr Weston. "Some Examples of Pollution of Streams by Industrial Wastes". Sanitary Section, May 6, 1929; June, 1929, JOURNAL.
March 21, 1934	Paul F. Howard. "Sewer Assessment Practice in Massachusetts". Sanitary Section, March 1, 1933; September, 1933, JOURNAL.
March 20, 1935	Arthur L. Shaw. "Newton High Level Sewer". Sanitary Section, March 7, 1934; April, 1934, JOURNAL.
March 18, 1936	Stanley M. Dore. "Design and Progress on Construction of Dams for Quabbin Reservoir". Sanitary Section, May 1, 1936; July, 1935, JOURNAL.
March 17, 1937	Almon L. Fales. "Chemical Precipitation of Sewage and Industrial Wastes". Sanitary Section, April 1, 1936; October, 1936, JOURNAL.

*Last award of copies of "Frontinus and the Water Supply of the City of Rome."

- March 16, 1938—Robert Spurr Weston. "The Treatment of Wool Scouring Waste". Sanitary Section, April 7, 1937; July, 1937, JOURNAL.
- March 15, 1939—George A. Sampson and Edwin B. Cobb. "Sewage Disposal System at Keene, N. H." Sanitary Section, December 7, 1938; January, 1939, JOURNAL.
- March 19, 1941—Thomas R. Camp. "The Filtration for the New M. I. T. Swimming Pool—Design and Operation". Sanitary Section, December 4, 1940; January, 1941, JOURNAL.

DESIGNERS SECTION

- | <i>Awarded at
Annual Meeting</i> | <i>Author and Subject of Paper</i> |
|--------------------------------------|---|
| March 19, 1925 | William D. Henderson. "Structural Design Features of a Hydro-Electric Development". Designers Section, February 11, 1925; April, 1925, JOURNAL. |
| March 17, 1926 | Barzillai A. Rich and William W. Bigelow, for their paper, "Stresses in a Composit Member Subjected to Bending and Direct Stress". Designers Section, January 13, 1926; February, 1926, JOURNAL. |
| March 16, 1927 | Ray H. Lindgren. "Design of Details in Timber Structures". Designers Section, April 14, 1926; May, 1926, JOURNAL. |
| March 21, 1928 | Clarence E. Carter. "Repairs to the Folly Hill Reservoir of the Salem Water Supply, Salem, Mass." Designers Section, November 9, 1927; November, 1927, JOURNAL. |
| March 16, 1932 | J. Stuart Crandall. "Piles and Pile Foundations". Designers Section, March 10, 1931; May, 1931, JOURNAL. |
| March 15, 1933 | Howard A. Gray. "Moisture Penetration in Exterior Walls". Designers Section, November 12, 1931; March, 1932, JOURNAL. |
| March 17, 1937 | Herman G. Dresser. "Some Features of Sewer and Culvert Design". Designers Section, March 11, 1936; October, 1936, JOURNAL. |
| March 16, 1938 | John B. Wilbur. "Model Analysis of Structures". Designers Section, December 8, 1937; January, 1938, JOURNAL. |
| March 20, 1940 | Dean Peabody, Jr. "Continuous Frame Analysis of Flat Slabs". Designers Section, March 8, 1939; July, 1939, JOURNAL. |
| March 19, 1941 | Richard S. Holmgren. "The Pittsburgh Conservation Reservoir Development of the New Hampshire Water Resources Board". Joint Meeting, February 14, 1940; April, 1940, JOURNAL. |
| March 18, 1942 | Chester J. Ginder and Edwin B. Cobb. "Design of Fabricated Plate Steel Tees, Laterals and Wyes of Large Diameters for the Pressure Aqueduct of the Boston Metropolitan District Water Supply Commission". Designers Section, November 14, 1940; April, 1941, JOURNAL. |

HIGHWAY SECTION

- | <i>Awarded at
Annual Meeting</i> | <i>Author and Subject of Paper</i> |
|--------------------------------------|--|
| March 17, 1927 | LeRoy M. Hersum. "Structural Design of Concrete Roads". Highway Section, December 22, 1926; February, 1927, JOURNAL. |
| March 19, 1930 | Arthur W. Dean. "Massachusetts Highways". Joint Meeting, November 20, 1929; December, 1929, JOURNAL. |

March 20, 1946—Prof. Ernest L. Spencer. "Aerial Mapping Equipment". Joint Meeting, Main Society and Highway Section, February 28, 1945; April, 1945, JOURNAL.

HYDRAULICS SECTION

<i>Awarded at Annual Meeting</i>	<i>Author and Subject of Paper</i>
March 17, 1943	Karl R. Kennison. "Hydraulics of the New Pressure Aqueduct of the Metropolitan Water District". Hydraulics Section, November 18, 1941; January, 1942, JOURNAL.
March 22, 1944	Thomas R. Camp. "Velocity Gradients and Internal Work in Fluid Motion". Joint Meeting, May 19, 1943; October, 1943, JOURNAL.
March 21, 1945	Edwin B. Cobb. "Flow of Water in Network Piping System". Hydraulics Section, February 2, 1944; October, 1944, JOURNAL.
March 20, 1946	William F. Covil (Posthumously). "A Practical Formula for the Flow of Water in Pipes". Hydraulics Section, November 1, 1944; January, 1945, JOURNAL.

NORTHEASTERN UNIVERSITY SECTION PRIZE AWARDS

Authorized by vote of Board of Government on March 10, 1931 and awarded for an original paper prepared by a member of the Northeastern University Section of Boston Society of Civil Engineers and presented by the author during the year at a regular Engineering Conference meeting. The prize consists of books.

<i>Awarded at Annual Meeting</i>	<i>Author and Subject of Paper</i>
March 20, 1940	Louis G. Reiniger. "How Combat Engineers Span a River". Northeastern University Section, November 3, 1939.
March 19, 1941	John E. Bamber. "Construction of Spur Railway Track to Camp Edwards". Northeastern University Section, January 10, 1941.
March 18, 1942	Warren T. Boutelle. "Sewage Treatment at Camp Edwards". Northeastern University Section, May 21, 1941.

BOSTON SOCIETY OF CIVIL ENGINEERS SCHOLARSHIP
IN MEMORY OF DESMOND FITZGERALD

AWARDED TO STUDENTS IN CIVIL ENGINEERING AT NORTHEASTERN UNIVERSITY

In accordance with action by Board of Government on March—, 1931, in establishing the Boston Society of Civil Engineers Scholarship in memory of Desmond FitzGerald, former Past President and Honorary Member of the Society, and in keeping with the intent of the donor that the income from the fund "be used for charitable and educational purposes."

<i>Awarded</i>	<i>Recipient</i>	<i>Awarded</i>	<i>Recipient</i>
April 16, 1931	Raymond E. Edson	May 17, 1939	Norman B. Cleveland
April 20, 1932	John L. Freiheit	May 8, 1940	Daniel W. Miles
May 17, 1933	Rolf E. Hamstrom	April 24, 1941	Walter B. Kelley
April 24, 1935	Kenneth F. Knowlton	April 22, 1942	Richard D. Sutliff
April 22, 1936	James L. Dallas	March 31, 1943	Irving T. Berkland
May 5, 1937	Leslie W. Lenfest	Nov. 3, 1943	Joseph C. Lawler
May 4, 1938	Chesley F. Garland		

BOSTON SOCIETY OF CIVIL ENGINEERS SCHOLARSHIP
JOHN R. FREEMAN FUND

In 1925 the late John R. Freeman, a Past President and Honorary Member of the Society made a gift to the Society of securities which was established as the John R. Freeman Fund. The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to this Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, reports of which would be presented to the Society.

<i>Recipient</i>	<i>Period of Scholarship</i>
Kenneth C. Reynolds	July, 1927 - June, 1929 (2 yrs.)
Samuel Shulits	July, 1928 - June, 1930 (2 yrs.)
Clifford P. Kittredge	July, 1930 - June, 1932 (2 yrs.)
Lawrence L. DeFabritis	July, 1932 - June, 1933 (1 yr.)
Leslie J. Hooper	July, 1934 - June, 1936 (2 yrs.)
Martin A. Mason	July, 1937 - June, 1938 (1 yr.)

OF GENERAL INTEREST

ANNOUNCEMENT OF BOSTON SOCIETY OF CIVIL ENGINEERS SCHOLARSHIP

JOHN R. FREEMAN FUND

The John R. Freeman Fund Committee will receive applications for a scholarship covering a year's study or research work in connection with hydraulics or an allied science. A stipend of \$2400 will be provided for tuition, traveling and living expenses for a single man, \$3000 for a married man.

To be eligible for this scholarship, a candidate shall be an American citizen, not less than 24 years of age, who is a graduate of a technical school of recognized standing. Preference will be given to residents of New England and eastern New York north of New York City. It is desirable that candidates be members of the Boston Society of Civil Engineers, but this is not a requirement.

Applications addressed to the Freeman Fund Committee, c/o the Secretary of the Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass., must be received not later than July 15, 1946. The candidate should set forth in his application his qualifications, age, place of birth, education,

experience and references. He should describe in detail just what he proposes to study if awarded this scholarship, with a statement whether additional money will be needed for apparatus or equipment and if so how much. The application should be accompanied by a photograph and not less than five letters of reference addressed to the Secretary of the Society.

The award will be made to a candidate who has indicated in his application the best way in which this fund can be used for the benefit of the science of hydraulics and who, in the opinion of the Committee, is qualified to carry the work through to satisfactory completion. The Committee assumes no obligation to make any award if in its opinion no subject or candidate is considered worthy of it.

GEORGE A. SAMPSON,

President

EVERETT N. HUTCHINS,
Secretary

May 20, 1946.

PRIZES AWARDED AT ANNUAL MEETING ON MARCH 20, 1946

The Desmond FitzGerald Award

TO PROF. ALBERT G. H. DIETZ, MEMBER

Presentation made by President Carroll A. Farwell

Mr. Arthur D. Weston, Chairman of the Committee on Award of the Desmond FitzGerald Award, consisting of

Arthur W. Dean, Emil A. Gramstorff, and Mr. Weston, outlined the purpose of this prize which was insti-

tuted and endowed in 1910 by the late Desmond FitzGerald, a Past President and Honorary Member of this Society. This award is given annually for a paper presented by a member and published during the year, which is adjudged worthy of special commendation for its merit. The paper selected by this committee and recommended to the Board of Government or the Award was that by Prof.

Albert G. H. Dietz, member, entitled "Details of Design with Timber Connectors", presented at a meeting of the Designers Section, held on October 13, 1943, and published in the January, 1945, JOURNAL.

President Farwell on behalf of the Board of Government presented the Desmond FitzGerald Award to Prof. Albert G. H. Dietz.

Clemens Herschel Award

TO PROF. CHARLES O. BAIRD, JR., MEMBER

Presentation made by President Carroll A. Farwell

Prof. Emil A. Gramstorff, member of the Committee on Prize Awards, outlined the purpose of the Clemens Herschel Award which was established by a gift from the late Clemens Herschel, a Past President and Honorary Member of this Society, and is awarded for a paper which has been particularly useful and commendable and worthy of recognition. This year the prize was awarded to Prof. Charles O. Baird, Jr., member, for his paper on "Photo-

grammetry", presented at a Joint meeting of the Main Society and Highway Section, held on February 28, 1945, and published in the April, 1945, JOURNAL. The prize consisted of books: "Fluid Mechanics for Hydraulic Engineers", by Hunter Rouse; "Mathematical Theory of Probabilities, Application to Frequency Curves and Statistical Method", by Arne Fisher; "Theoretical Soil Mechanics", by Karl Terzaghi.

Highway Section Award

TO PROF. ERNEST L. SPENCER, MEMBER

Presentation made by President Carroll A. Farwell

Mr. Arthur W. Dean, Chairman of the Highway Section Prize Award Committee, consisting of Charles O. Baird, Hermon S. Swartz, and Mr. Dean, outlined the purpose of the Highway Section Award which was authorized by the Board of Government in 1924 to be given for a worthy paper given in the Section by a member of the Section.

The paper selected was entitled "Aerial Mapping Equipment", by Prof.

Ernest L. Spencer, member, presented at a Joint Meeting of the Main Society and Highway Section, held on February 28, 1945, and published in the April, 1945, JOURNAL.

The prize consisted of books: "Geology and Engineering", by Robert F. Legget; "Theoretical Soil Mechanics", by Karl Terzaghi; "Construction Planning and Plant", by Ackerman & Locher.

Hydraulics Section Prize

TO EDWIN B. COBB, MEMBER

Deferred Presentation made by President Carroll A. Farwell

The Hydraulics Section Prize at the last Annual Meeting, March 21, 1945, was awarded to Mr. Edwin B. Cobb, member, but on account of his tour of duty in the U. S. Navy and Civil Engineer Corps, the presentation was deferred to this annual meeting.

Mr. George W. Coffin, member of the Committee on Award of the Hydraulics Section Prize, introduced the recipient. The President presented the Prize to Mr. Cobb for his paper on "Flow of Water in Network Piping

System", presented at a meeting of the Hydraulics Section held on February 2, 1944 and published in the October, 1944 JOURNAL.

The prize consists of the following books:

"Elementary Mechanics of Fluids," by Hunter Rouse.

"Piping Handbook," by Sabin Crocker.

"Engineering Contracts and Specifications," by Robert W. Abbett.

"Centrifugal Pumps and Blowers," by A. H. Church.

Hydraulics Section Prize

POSTHUMOUSLY TO WILLIAM F. COVIL, MEMBER

Presentation made by President Carroll A. Farwell

The President announced that in accordance with the recommendation of the Committee on Award of the Hydraulics Section Prize, the Board of Government VOTED to award the Hydraulics Section Prize posthumously to William F. Covill, Member, for his paper on "A Practical Formula for the

Flow of Water in Pipes", presented at a meeting of the Hydraulics Section, held on November 1, 1944, and published in the January, 1945, JOURNAL. The prize consisted of a book "Lincoln Library of Essential Information", which was sent to Mr. Covill's daughter, Norma Jean Covil.

Newly Elected Honorary Member

CHARLES MILTON SPOFFORD

Presentation of Certificate by President Carroll A. Farwell

Honorary Membership in the Boston Society of Civil Engineers was conferred on Prof. Charles Milton Spofford at the Annual Meeting of the Society held on March 20, 1946. Following the Annual Dinner, President Carroll A. Farwell presented the new Honorary Member a certificate of Honorary Membership, framed in a morocco leather case.

PROF. CHARLES MILTON SPOFFORD, Partner, Fay, Spofford & Thorndike, Boston, Mass., has been a member of the Society since April 17, 1901.

The certificate of Honorary Membership reads as follows:

"In recognition of his outstanding achievements in the fields of civil engineering education and of advanced structural design."

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

JANUARY 23, 1946.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the 20th Century Association, 3 Joy Street, Boston, and was called to order by President Carroll A. Farwell at 7:00 P.M. Fifty-five members and guests were present and fifty persons attended the dinner. This was a Joint Meeting with the Hydraulics Section, BSCE.

President Farwell announced the death of the following member:—

Prof. J. Donald Mitsch, who was elected a member May 21, 1924, and who died January 18, 1946.

The President stated that the place of the February meeting would be announced later. The speaker will be a representative of the Monsanto Chemical Company, who will give a talk on Plastics in the construction and sanitary field.

The Secretary announced the election of the following to membership on this date:—

Grade of Member:—A. Herbert Bruce, Vincent R. Caputo, Albert S. Hall, Clifford S. Mansfield, John J. Scanlon, Daniel W. Miles,* Edward F. Wilcox,* Abraham Woolf.*

President Farwell called upon Prof. Harold A. Thomas, Jr., Vice-Chairman, Hydraulics Section, to carry on any necessary business for that Section.

President Farwell introduced the speaker of the evening, Mr. Bryant L. Hopkins, Hydraulic Engineer and Manager, Kennebec Water Power Company, Bangs Station, Waterville, Maine, who gave a very interesting talk on

"Experiences in Making a River Serve Multiple Users". The talk was followed by a question period.

A rising vote of thanks was given the speaker.

Adjourned at 8:30 P.M.

EVERETT N. HUTCHINS, *Secretary*

FEBRUARY 20, 1946.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the 20th Century Association, 3 Joy Street, Boston, Mass., and was called to order by President Carroll A. Farwell, at 7:00 P.M. Twenty-seven members and guests were present and twenty-seven persons attended the dinner.

President Farwell announced the death of the following members:—

J. Leslie Woodfall, who was elected a member April 18, 1888, and who died March 20, 1945.

Theodore R. Kendall, who was elected a member October 17, 1917, and who died February 4, 1946.

Ralph Whitman, who was elected a member March 16, 1904, and who died February 3, 1946.

Joseph R. Hews, who was elected a member March 16, 1898, and who died January 28, 1946.

The President announced that the Annual Meeting March 20, 1946, would be held at the Boston City Club, 14 Somerset Street, Boston, Mass. A Symposium will be presented on the subject, "The Role of the Civil Engineer in World War II". The speakers will be Prof. John E. Burchard, Director of Libraries, Mass. Institute of Technology; John B. Wilbur, Acting Head, Department of Civil Engineering, Mass. Institute of Technology; and LeRoy A. Brothers, Chief Operations Analyst, Operations Analysis,

*Transfer from Grade of Junior.

Headquarters Army Air Forces, Washington, D. C.

President Farwell introduced the speaker of the evening:—Mr. E. S. Childs, of the Plastics Division of Monsanto Chemical Company, Springfield, Mass., who gave a very interesting talk on "Use of Plastics in Civil Engineering". Several different samples of plastics were exhibited.

A rising vote of thanks was given the speaker.

Adjourned at 8:45 P.M.

EVERETT N. HUTCHINS, *Secretary*

MARCH 20, 1946.—The ninety-eighth annual meeting of the Boston Society of Civil Engineers was held today at the Boston City Club, and was called to order at 3:30 P.M., by the President, Carroll A. Farwell.

The minutes of all previous meetings of the current fiscal year which have been printed in the various issues of the JOURNAL were approved as printed.

The Secretary reported the election of the following members on this date:—

Grade of Member.—Howard B. Allen, John F. Flaherty, Clifford E. Moffett, Charles A. Perkins, John J. Scheuren, Jr., Charles M. Kelley,* John H. Manning,* Arthur J. Yardley.*

Grade of Student.—S. Raymond Desmarais, Thomas B. Freyer, Jr., Louis L. Lunetta, Paul M. Massad, Robert F. Pierce, Rudolph C. Radigan, Robert H. Sprenger, Bernard F. Stone.

The Annual Reports of the Board of Government, Treasurer, Secretary and Auditors were presented. Reports were also made by the following committees: Hospitality, Welfare, Relation of Sections to Main Society, Library, John R. Freeman Fund, Subsoils of Boston.

VOTED that the reports be accepted with thanks and placed on file and

*Transfer from Grade of Junior.

that they be printed in the April, 1946, JOURNAL.

VOTED that the incoming Board of Government be authorized to appoint such committees as it deems desirable.

The members voted in favor of the change in name of the Highway Section to Transportation Section.

The report of the Tellers of Election, Herbert D. Hurley and Murray H. Mellish, was presented and in accordance therewith the President declared the following had been elected officers for the ensuing year:—

President—George A. Sampson.

Vice-President (for two years)—

Frederic N. Weaver.

Secretary (for one year)—Everett N. Hutchins.

Treasurer (for one year)—Chester J. Ginder.

Directors (for two years)—Frank L. Flood, Donald W. Taylor.

Nominating Committee (for two years)—Charles O. Baird, Allen J. Burdoin, Frank L. Lincoln.

The retiring President, Carroll A. Farwell, then gave his address on "The Engineer's Part in Community Life".

Fifty-five members and guests attended this part of the meeting.

The meeting adjourned to assemble at 7:30 P.M., the Annual Dinner being held in the interim.

The President then called the meeting to order for the evening program.

President Farwell read a letter from Prof. C. Frank Allen, Honorary Member and our oldest member, stating that he would not be able to attend. On motion made by Mr. Arthur W. Dean, duly seconded, it was VOTED that the Secretary be instructed to express to Prof. Allen, our appreciation of his loyalty to the Society and our best wishes.

Presentation of Prizes

The President requested Mr. Arthur D. Weston, Chairman of the Desmond Fitzgerald Award Committee, to out-

line the purpose of this prize and to present the candidate for the prize. The President on behalf of the Society, then made the presentation of the Desmond Fitzgerald Award to Prof. Albert G. H. Dietz, member, for his paper on "Details of Design with Timber Connectors", presented at a meeting of the Designers Section, held on October 13, 1943, and published in the January, 1945, JOURNAL. President Farwell explained that the Medal is not yet available but a certificate is given now and it is expected the medal will be ready in June.

The President requested Prof. Emil A. Gramstorff, member of the Prize Award Committee, to outline the purpose of the Clemens Herschel Award and to present the candidate. The President on behalf of the Society then made the presentation of the Clemens Herschel Award to Prof. Charles O. Baird, Jr., member, for his paper on "Photogrammetry", presented at a Joint Meeting of the Main Society and the Highway Section, held on February 28, 1945, and published in the April, 1945, JOURNAL. The prize consisted of the following books:—

"Fluid Mechanics for Hydraulic Engineer", by Hunter Rouse.

"Mathematical Theory of Probabilities, Application to Frequency Curves and Statistical Method", by Arne Fisher.

"Theoretical Soil Mechanics", by Karl Terzaghi.

The President requested Arthur W. Dean, Chairman of the Highway Section Award Committee, to outline purposes of the Highway Section Award and to present the candidate for the prize. The President on behalf of the Society, then made the presentation of the Highway Section Prize to Prof. Ernest L. Spencer, member, for his paper on "Aerial Mapping Equipment", presented at a Joint Meeting of the Main Society with the Highway Sec-

tion, held on February 28, 1945, and published in the April, 1945, JOURNAL. The prize consisted of the following books:—

"Geology and Engineering", by Robert F. Legget.

"Theoretical Soil Mechanics", by Karl Terzaghi.

"Construction Planning and Plant", by Ackerman & Locher.

The President stated that last year the Society awarded the Hydraulics Section Prize to Edwin B. Cobb, member, but that Mr. Cobb's tour of duty in the U. S. Navy and Civil Engineer Corps did not permit him to be present. His return now gives us the opportunity to make the presentation to him. President Farwell requested Mr. George W. Coffin, to outline purpose of Hydraulics Section Prize Award and to introduce the recipient. President Farwell on behalf of the Society, then made the presentation of the Hydraulics Section Prize to Edwin B. Cobb, member, for his paper on "Flow of Water in Network Piping System", presented at a meeting of the Hydraulics Section held on February 2, 1944, and published in the October, 1944, JOURNAL. The prize consisted of the following books:—

"Elementary Mechanics of Fluids", by Hunter Rouse.

"Piping Handbook", by Sabin Crock-er.

"Engineering Contracts and Specifications", by Robert W. Abbett.

"Centrifugal Pumps and Blowers", by A. H. Church.

President Farwell stated that this year the Board of Government had awarded the Hydraulics Section Prize, for the current year, posthumously to William F. Covil, member, for his paper on "A Practical Formula for the Flow of Water in Pipes", presented at a meeting of the Hydraulics Section held on November 1, 1944, and published in the January, 1945, JOURNAL.

The prize selected is a book entitled "The Lincoln Library of Essential Information", following suggestions from the family, and the book has been sent to Mr. Covil's daughter, Norma Jean Covil.

New Honorary Member

President Farwell then announced that Honorary Membership in the Society had been conferred on one of the Society's distinguished members, in accordance with the vote of the Board of Government on December 19, 1945, as follows:—Charles Milton Spofford, who has been a member since April 17, 1901. The President requested Mr. Charles R. Gow, Honorary Member, to present the candidate. President Farwell then made the presentation of the Honorary membership certificate to Prof. Charles Milton Spofford.

The certificate presented read as follows:—

Boston Society of Civil Engineers

In recognition of his outstanding achievements in the fields of civil engineering education and of advanced structural design

CHARLES MILTON SPOFFORD

has been duly elected an

HONORARY MEMBER

By direction of the Board of Government
December 19, 1945

CARROLL A. FARWELL

President

EVERETT N. HUTCHINS (Seal)
Secretary

President Farwell then introduced the guest speakers of the evening, Prof. John E. Burchard, Director of Libraries, Mass. Institute of Technology; Prof. John B. Wilbur, Acting Head, Department of Civil Engineering, Mass. Institute of Technology; Dr. LeRoy A. Brothers, Chief Operations Analyst, Operations Analysis, Headquarters Army Air Forces, Washington, D. C., who gave a most interesting symposium on "The Role of the Civil Engineer in

World War II". The talks were illustrated with lantern slides.

At the conclusion of this address, President Farwell introduced the newly elected President, George A. Sampson, who then assumed the chair and adjourned the meeting.

One hundred ninety-eight members and guests attended the dinner.

Meeting adjourned at 10:10 P.M.

EVERETT N. HUTCHINS, *Secretary*

SANITARY SECTION

DECEMBER 5, 1945.—A meeting of the Sanitary Section was held at the Society Rooms at 7:15 P.M. on the above date, with 48 persons present.

Upon motion duly made and seconded, it was voted that the Chairman appoint a Nominating Committee to recommend candidates for officers of the section and members of the Executive Committee for the year beginning March 6, 1946. Chairman Mellish thereupon appointed a Nominating Committee as follows:—

G. W. Coffin, *Chairman*

C. O. Baird, Jr.

W. L. Hyland

The speaker of the evening was Gordon M. Fair, Abbott and James Lawrence Professor of Engineering, and Gordon McKay Professor of Sanitary Engineering, Harvard University. Professor Fair presented an interesting and instructive paper, entitled "New Enemies and Old Friends in Sanitary Engineering", which was illustrated with lantern slides. The speaker discussed three diseases which have been found in recent years to be spread through or by means of water—namely, infectious hepatitis, amoebic dysentery and schistosomiasis. He also discussed the possibility of controlling the spread of these diseases by the well-known methods of water purification.

After a considerable general discussion, the speaker was accorded a rising

vote of thanks and the meeting adjourned about 9 P.M.

Respectfully submitted,
GEORGE C. HOUSER, *Clerk*

DESIGNERS' SECTION

JANUARY 9, 1946.—Following an informal dinner at the Ambassador Restaurant, the Designers' Section of the Boston Society of Civil Engineers met at the Society Rooms, 715 Tremont Temple, Boston. Chairman Frank L. Lincoln called the meeting to order at 6:35 P.M.

The Clerk's report of the previous meeting was read and accepted.

A motion was made and passed that the Chairman appoint a nominating committee to submit a slate of officers to be voted on at the annual meeting in March. Mr. Lincoln appointed the following nominating committee:

Mr. Lawrence M. Gentleman,

Chairman

Mr. Herman G. Protze, Jr.

Prof. Emil A. Gramstorff

Mr. Lincoln introduced the speaker of the evening, Mr. Herman G. Protze, Jr., Engineer in Charge of Laboratory Work and Field Control, The Thompson & Lichtner Co., Inc., Boston, who presented a paper entitled: "Investigation of Causes of Defective Concrete—Their Prevention, Correction and Evaluation."

The speaker described the various standard and special laboratory and field tests utilized to determine the presence of deleterious substances in mixing water and concrete aggregates. Great emphasis was directed to the importance of conducting the tests as the results of laboratory investigations indicate conclusively that the introduction of small amounts of deleterious substances in the mix produces a substantial reduction in the ultimate strength and durability of concrete.

An open discussion period followed the reading of the paper.

The meeting, attended by 56 members and guests(adjourned at 8:50 P.M.

HENRY I. WYNER, *Clerk*

FEBRUARY 13, 1946.—A meeting of the Designers' Section of the Boston Society of Civil Engineers was held at the Society Rooms, 715 Tremont Temple, Boston, at 6:35 P.M., following an informal dinner at the Ambassador Restaurant. Chairman Frank L. Lincoln presided.

The Clerk's report of the previous meeting was read and accepted.

The nominating committee comprising Lawrence M. Gentleman, Chairman. Herman G. Protze and Emil A. Gramstorff submitted the following slate of officers for the coming year:

For *Chairman*: Dean Peabody, Jr.

Vice-Chairman: Henry I. Wyner

Clark: Ernest L. Spencer

Executive Committee:

James F. Brittain

Arthur E. Harding

Oliver G. Julian

Mr. Lincoln introduced the speaker of the evening, Mr. Henry Brask, Engineer, George P. Carver Engineering Co., Boston, who presented a paper entitled: "Unloading Towers for Handling Bulk Materials."

The speaker described in general the arrangement, capacities and design of various types of high speed unloading towers used at East Coast Ports for discharging coal from ships, which towers are adaptable to the handling of other bulk materials with some modification in the design. Presentation of the paper was supplemented by slides which illustrated the various types of towers in use and the several methods used to distribute the unloaded materials.

An open discussion period followed the reading of the paper.

The meeting, attended by 22 members and guests, was adjourned at 7:45 P.M.

HENRY I. WYNER, *Clerk*

MARCH 13, 1946.—The March meeting of this section was held in the Society Rooms, 715 Tremont Temple, following an informal dinner at the Ambassador Restaurant.

Chairman Frank L. Lincoln called the meeting to order at 6:45 P.M. The Clerk's report of the previous meeting on February 13, 1946, was read and accepted. Mr. Lawrence M. Gentleman read a report of the Nominating Committee. As there were no further nominations from the floor, Mr. Lincoln declared the slate of officers elected.

Chairman—Dean Peabody, Jr.

Vice-Chairman—Henry I. Wyner

Clerk—Ernest L. Spencer

Executive Committee—James F.

Brittain, Arthur E. Harding, Oliver G. Julian.

As there was no further business to be transacted, Mr. Lincoln introduced Mr. Carroll A. Farwell, President of the Boston Society of Civil Engineers, who extended the greetings of the Main Society. Mr. Farwell then introduced the speaker of the evening, Mr. Daniel O. Cargill, Bridge Engineer, Rhode Island Department of Public Works.

Mr. Cargill, after briefly describing the Administrative set-up in his Department, proceeded to discuss some of the design details concerned with both the Construction and Maintenance of bridges in his state. In as much as the state has a complete photographic record of each bridge from the time actual work begins on construction until completion of the work and then a series of photos taken by the Maintenance Department, his talk was profusely illustrated. The main topics covered were (1) Consideration of moisture; ways and means of keeping out moisture;

permitting escape of moisture and (2) Temperature effects—expansion joints and difficulties of maintaining and repairing them.

Pictures of similar problems encountered in California were shown for comparison.

A lengthy discussion period followed the talk.

Attendance—forty members and guests.

Meeting adjourned at 8:45 P.M.

ERNEST L. SPENCER, *Clerk*

HIGHWAY SECTION

FEBRUARY 27, 1946.—The Annual Meeting of the Highway Section of the Boston Society of Civil Engineers was held this evening at 7:30 P.M., at Richards Hall, Northeastern University, following an informal dinner at the Old France Restaurant. Twenty-three persons attended the meeting.

The chairman, William C. Paxton, read the report of the Nominating Committee presenting nominations for officers for the coming year.

The Secretary was authorized and directed to cast one vote for the slate of officers.

The following officers were elected:—

Chairman—Francis T. McAvoy.

Vice-Chairman—George W. Hankinson.

Clerk—John F. Shea.

Executive Committee—William C.

Paxton, John B. Babcock, Thomas C. Coleman.

The speaker of the evening was Mr. Philip Kitfield, Assistant Project Engineer, Massachusetts Department of Public Works, who gave an extremely interesting talk on "Massachusetts Department of Public Works Solution to the Traffic Problems in Boston". An interesting discussion period followed the talk.

Adjourned at 9:30 P.M.

GEORGE W. HANKINSON, *Clerk*

HYDRAULICS SECTION

JANUARY 23, 1946.—A joint meeting of the Boston Society of Civil Engineers with the Hydraulics Section was held this evening at the Twentieth Century Association. Fifty-four members and guests attended the meeting and dinner.

President Farwell introduced the speaker of the evening, Mr. Bryant L. Hopkins, Hydraulic Engineer and Manager, Kennebec Water Power Co., who spoke on "Experiences in Making a River Serve Multiple Users." An interesting discussion period followed the talk, and then a rising vote of thanks was given the speaker.

J. G. W. THOMAS, *Clerk*

FEBRUARY 6, 1946.—A meeting of the Hydraulics Section was held in the Society rooms, 715 Tremont Temple, following a dinner at the Ambassador Restaurant. During a business meeting conducted by Vice-Chairman Harold A. Thomas, Jr., the report of the nominating committee was read. In the ensuing vote the following were elected to serve as officers for the coming year.

Chairman: Harold A. Thomas, Jr.

Vice-Chairman: Leslie J. Hooper

Clerk: John G. W. Thomas

Members of the Executive Committee: James F. Brittain

Elliot F. Childs

Gardner K. Wood

The speaker of the evening was Murray H. Mellish, Hydraulic Engineer, New England Division U. S. Engineers Office, who spoke on "Hydraulic Features of a Flood Control Project". Slides showing finished and proposed flood control projects in the Merrimack and Connecticut valleys were also shown.

An unusually lively discussion after the talk was evidence of the interest in the material presented by Mr. Mellish. The meeting adjourned at 8:50,

with a rising vote of thanks to the speaker.

Thirty-eight members and guests attended the meeting.

JOHN G. W. THOMAS, *Clerk*

APPLICATIONS FOR MEMBERSHIP

[MARCH 15, 1946]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

John S. Bethel, Jr., Wakefield, Mass. (b. November 12, 1915, Winthrop, Mass.). Graduated from Massachusetts Institute of Technology in 1938, with B.S. degree in Sanitary Engineering. Experience, September, 1938, to December, 1938, with the U. S. Geological Survey Water Resources Branch, engaged in determining in the field and computing run-off after the 1938 hurricane; December, 1938, to

November, 1940, engaged by Metcalf & Eddy, Boston, Mass., to supervise water and sewage plant operation, including training of operators; November, 1940, to February, 1941, with Charles T. Main, Inc., Boston, Mass., to check the water distribution system of Camp Edwards, Mass., for adequacy under fire-flow conditions; February, 1941, to May, 1941, with Metcalf & Eddy, to design drainage system at an Army Airfield and to design certain portions of an industrial waste treatment plant; May, 1941, to January, 1942, 1st Lt., Corps of Engineers, U. S. Army, acting as engineering officer; January, 1942, to June, 1942, 1st Lt. CE U. S. Army, area engineer on construction of Army Air Base at New-castle, Delaware; June, 1942, to May, 1944, Capt. CE U. S. Army, responsible for all construction done by Army in New York, New Jersey and Delaware, that was not part of an initial program, this amounted to approximately \$5,000,000. Responsibility was limited to determination as to necessity and to methods of construction to be used. May, 1944, to January, 1946, Capt. CE U. S. Army, responsible for the operation and maintenance of all army water and sewage plants in New York, New Jersey and Delaware, as well as all refuse collection and disposal and insect and rodent control. January, 1946, to date, with Metcalf & Eddy, as a project engineer on the design of sanitary facilities. Refers to *T. R. Camp, E. S. Chase, F. L. Flood, A. L. Shaw.*

Richard C. Dwyer, Jamaica Plain, Mass. (b. May 15, 1911, Boston, Mass.) Experience, July, 1928, Highway Division, City of Boston, as rodman. Have been employed by this division up to present time. Attended evening schools at the Lincoln Institute and the Lowell Institute and passed Massachusetts Civil Service examinations, Civil Engineer, Grade I, March 14, 1929; Civil

Engineer, Grade II, May 6, 1931; Civil Engineer, Grade IV, March 3, 1937; Civil Engineer, Grade V, March 18, 1942. In addition, am certified by the Massachusetts Board of Registration of Professional Engineers. Have held the positions of Chief of Party, maintenance engineer, assistant to division engineer and chief engineer of the Boston Highway Division and served as an officer in the United States Army, Corps of Engineers, from 1943 to 1946. At present am employed as Division Engineer of the City of Boston Highway Division. Refers to *S. J. Tomasello, W. T. Morrissey, J. J. Murphy, L. M. Stewart.*

Charles Y. Hitchcock, Jr., Boston, Mass. (b. February 15, 1917, Quincy, Mass.). Graduated from Dartmouth College, Class of 1938, A.B. degree in Civil Engineering. In 1939, graduated from Thayer School of Engineering with a degree in Civil Engineering. Experience, June, 1939, worked for Gannett Eastman & Fleming in Harrisburg, Pa., drafting, minor design and inspecting on the water supply for the City of Harrisburg (Clark's Valley Dam) under the Chief Engineer. Left there to go to Panama for the Special Engineering Division as a student engineer (Hydraulic) was promoted to junior and then assistant engineer (Hydraulic). The last year had charge of construction and testing the final lock model design and began the final report. After twenty-five months, came back on leave, in May, 1942. While on leave helped out at Thayer School with the title of instructor. Taught Reinforced Concrete and Advanced Surveying for one semester. Immediately following the end of the semester in late August, 1942, I joined the Navy CE Corps with the rank of Ensign. During my tour with the 28th US N.C.B., I spent 9 months in Iceland, 2 months in England, 8 months in France and finally 8 months in Okinawa advancing to Lieu-

tenant and Company Commander. On March 19, 1946, I was released from active duty and am at present working for Metcalf & Eddy, Engineers, Boston, Mass. Refers to *F. L. Flood*, *F. A. Marston*, *R. J. Rice*, *C. W. Rolfe*, *A. L. Shaw*.

Oscar H. Horovitz, Newton, Mass. (b. December 7, 1899, Chelsea, Mass.) Graduated from Massachusetts Institute of Technology, class of 1922. Associate Member, American Society of Civil Engineers. Experience, 1922-1926, Corrugated Bar Company and Kalman Steel Company; 1926 to date, engineer and general manager, Oscar H. Horovitz Company, Steel Erectors, Cambridge, Mass., also General Partner. Refers to *A. Adelman*, *A. E. Harding*, *G. T. Rooney*, *A. Woolfe*.

Transfer from Grade of Junior

Herbert J. Albee, Lynn, Mass. (b. August 7, 1917, Boston, Mass.) Graduated from Wentworth Institute in 1937. Experience, 1937-1946, with Cleverdon, Varney & Pike, drafting, structural design, report writing and office supervision. 1942-1943, U.S.N. Construction Bn. Refers to *L. S. Burke*, *F. M. Mahard*, *P. S. Rice*.

Robert R. Balmer, Marblehead, Mass. (b. August 15, 1913, Salem, Mass.) Graduated from Northeastern University in 1935, B.S. degree in Civil Engineering; Harvard University, M.S. in Sanitary Engineering, 1940; Massachusetts Registered Professional Engineer, 1946. Experience, July, 1937 to July, 1941, with Division of Sanitary Engineers, Mass. Department of Public Health, as Senior Sanitary Engineering Aid and Junior Sanitary Engineer. Most of this period was spent in the western district office making inspections and reports on public and semi-public water supplies and sewerage systems, nuisances, field tests, stream pollution problems and other related public

health engineering problems were investigated; from July, 1941 to May, 1942, with United States Public Health Service as Assistant Sanitary Engineer (Civil Service) and then with a reserve commission doing mosquito control work. Five months were spent in Kentucky developing program within the state. Five months were spent working in Kentucky, Ohio, Illinois and Indiana supervising the program in that area; from May, 1942 to present time with the Sanitary Corps, U. S. Army. Six months were spent as sanitary and medical inspector in camps in U. S. Two years were spent in Iran on water supply and sewage disposal. This work involved purification of over a billion gallons of water in more than 30 plants of the rapid, slow and pressure filter and distillation type. Work involved, inspection, recommendation, approvals, records and analysis interpretation. In Korea four months were spent in general public health work. Now on terminal leave and unemployed at present. Refers to *C. O. Baird, Jr.*, *F. H. Kingsbury*, *W. E. Merrill*, *A. D. Weston*.

Henry Campbell, Daytona Beach, Florida. (b. May 28, 1915, South Boston, Mass.) Graduated from Northeastern University in 1938, receiving B.S. Degree in Civil Engineering, with honor. Graduated from Harvard Graduate School of Engineering in 1940, receiving an M.S. degree in the field of Sanitary Engineering. Experience, November, 1937, to September, 1939, assistant town engineer, Town of Stoneham, Mass., worked on the design, layout, planning and supervision of all construction work done by the Stoneham Department of Public Works. Work included construction of roads, sewers, drains, and land surveys; July, 1940, to December, 1942, with Metcalf & Eddy, as assistant engineer, worked on the design of numerous army air fields, industrial wastes plants, water

treatment plants; with the Division of Sanitary Engineering, Massachusetts Department of Public Health, as an acting district engineer in charge of the Southeastern district. Work included supervision of municipal water treatment plants, sewage treatment plants, river pollution studies, and miscellaneous health problems. From December, 1943, to present date, have been a Lieutenant in the Sanitary Corps, U. S. Army, at present am the Sanitary Officer, Welch Convalescent Hospital, Daytona Beach, Florida. Refers to *G. M. Fair, F. L. Flood, M. J. Markham, R. M. Soule, A. D. Weston.*

Arnold B. Davis, Westwood, Mass. (b. May 13, 1915, Wollaston, Mass.) Graduated from Northeastern University in 1939, with B.S. degree in Civil Engineering. Cooperative work, was assigned as rodman and transitman in the City of Newton Engineering Department, Newton, Mass.; April, 1939-June, 1940, with the Metropolitan Water Supply on the Framingham Southborough Section of the Pressure Aqueduct, employed as a Junior Engineering Aid with duties of rodman, transitman and frequently Chief of Survey Party; 1940, entered my own business in contracting and engineering which lasted six months when I received a Federal appointment as Inspector of Army Ordnance Material (October, 1940). Remained with the Army Ordnance stationed at Springfield, Mass., until October, 1943, with duties of inspector at large for the district in charge of production and inspection of all Army Fuse Contracts. Duties required scheduling and expediting of indoctrination and an eight week course in Naval Ordnance at the Naval Gun Factory, Washington, D. C. Assigned as Chief Inspector and Personnel Officer with additional duties of alternate engineering and quality control officer on the Navy Proximity Fuse Production at

RCA, Victor Division, Camden, N. J. Was in direct charge of 100 military and civilian personnel and set and maintained all inspectional standards. On this assignment until January, 1946, when transferred to the Boston Office of the Navy Material Inspection and assigned to field duties in the contract termination division, duties here were the supervision of segregation and appraisal of various types of technical items on terminated navy contracts. Put on inactive status through accumulation of credits under the Navy discharge system. Since March, 1946, have been working as an assistant to the field engineer in charge of all construction for the Perford Construction Company, Framingham, Mass. Am on terminal leave status until May 3, 1946 as Lieut. (jg) USNR. Refers to *J. P. F. Cavazzoni, F. R. Dittami, E. A. Gramstorff, C. G. Hunt, Jr.*

Giles L. Evans, Jr., Fort Belvoir, Virginia. (b. November 30, 1914, Fayetteville, Tennessee). Vanderbilt University School of Engineering (Civil Engineering) 1932-1933; U. S. Military Academy, 1933, graduating in 1937, with B.S. degree. Commissioned in Corps of Engineers and assigned to River and Harbor duty as assistant to the District Engineer, Memphis, Tennessee, from September, 1937 to September, 1939. Served in dredging operations two months; Sunflower Cut-off clearing project, three months, constructed engineer camp for Wappapello Dam Project on St. Francis River, Mo., April-August, 1938; project engineer for construction of Marked Tree Siphon Project, Marked Tree, Ark., August, 1938 to September, 1939; this entailed \$150,000 levee repair project, using haul-in methods; inspection on concrete and foundation contract for siphon proper and supervision of fabrication, by U.S.E.D. forces, of the all-welded steel

siphons and pumping equipment therefor. Conducted field tests and discharge measurements on completed structure, June-September, 1939. Student at Massachusetts Institute of Technology, September, 1939 to September, 1940; candidate for M. of C.E. degree. Thesis work interrupted by war expansion of Army and was never submitted. Thesis was scale model study (3 scale ratios) of Marked Tree siphons, in Hydraulics Laboratory, M.I.T. Company Commander, Bn. Commander, Regiment Adjutant in 41st Engineering, Gen. Service Regiment, September, 1940 to November, 1941, at Fort Bragg, N. C., general training and engineer construction 811th Avn. Engr. Bn. (Ex. Off.) November, 1941-January, 1942 (Langley Field, Va.) Activation and general unit training S-3, 21st Avn. Engr. Regiment, Langley Field, January 1942. Ex. Off. 811th Engr. Avn. Bn. February-May, 1942, Langley Field. General training and activation of unit. Commanding Officer, 809th Engr. Avn. Bn., May, 1942-October, 1944. Joined Bn. at Westover Field, Mass. Moved overseas to England June 3, 1942; First American Engineer Unit to land in England-Scotland. Initiated construction of Heavy Bomber Base in Huntingdonshire—concrete pavements and permanent facilities. Landed in North Africa (Oran) November 11, 1942. A/D construction, including landing strips, PSP, macadam, asphalt in Algeria and Tunisia, to June, 1943. Landed in Sicily (Gela) July 10-14th, 1943. Built and maintained permanent and temporary A/D's until move to southeast Italy in October, 1943; Heavy bomber A/D construction, PSP, gravel, macadam, until July, 1944. Spear-headed invasion of Southern France, August, 1944. Constructed fighter bomber fields from beaches to Belfort Gap. Acted as Air Engineer on 7th Army Planning Staff for Southern France Operation between February and August, 1944. Left Bn.

and became Deputy Chief of Staff, Air Force Engineer Command (MTO) at Naples October-December, 1944. Returned to the United States December, 1944, assigned as member of Engineer Board at Fort Belvoir. Director of Technical Division I, charged with research and development in mapping, aerial photography, and demolitions. Captain, September, 1940; Major, July, 1942; Lieutenant Colonel, November, 1942; 7 campaign stars. Refers to *C. B. Breed, J. B. Babcock, W. M. Fife, D. W. Taylor, K. C. Reynolds.*

Leonard J. A. Fenocketti, Milton, Mass. (b. January 3, 1914, Boston, Mass.) Graduated from Tufts Engineering School in 1934, with B.S. degree in Civil Engineering (*magna cum laude*). Experience, July, 1934 to December, 1935, U. S. Geological Survey, rodman and recorder; December, 1935 to January, 1937, Metropolitan District Water Supply Commission as Junior Engineering Aide, work included drafting, engineering calculations and clerical work in connection with the Metropolitan Water Supply System; January, 1937 to January, 1938, Stone & Webster Engineering Corporation, Boston, Mass., as Designing Draftsman, structural steel and reinforced concrete drafting and design and surveying in connection with Power Plants and Industrial Buildings; May, 1938 to September, 1938, West End Iron Works, Cambridge, Mass., employed as a structural steel detailer in which position I made erection plans, detail drawings and estimated quantities for bids; September, 1938 to October, 1938, Massachusetts Department of Public Works (Highway Division) as a Junior Engineering Aide; October, 1938 to August, 1940, Metropolitan District Water Supply Commission, Boston, Mass., Senior Engineering Aide, drafting, design, checking designs and drawings and inspection work in connection with the Metropolitan Water Supply Pressure

Aqueduct; August, 1940 to May, 1943, George A. Fuller Company & Merritt Chapman & Scott Corporation, Quonset Point and Favisville, Rhode Island, as Assistant Structural Engineer. This work was on the structural engineering phases of various structures of Naval Bases; June, 1943 to February, 1946, Navy Department Bureau of Yards & Docks and Bureau of Aeronautics, Quonset Point and Davisville, R. I., as structural engineer, investigating and developing the structural engineering phases of projects laid out and prepared detailed plans, inspected existing structures, computed quantities and prepared cost estimates, supervised and checked work of others and designed. The projects were various Naval Bases on the East Coast. February, 1946 to date, Metropolitan District Water Supply Commission, Boston, Mass., assistant civil engineer. Checked design drawings for the Nut Island Sewage Treatment Plant. Refers to *S. M. Dore, L. M. Gentleman, K. R. Kennison, C. J. Ginder.*

Frederick B. Jackson, Auburndale, Mass. (b. August 16, 1917, Beverly, Mass.) Graduated from Newton High School in 1936, attended evening school at Lowell Institute. Graduated from Northeastern University in November, 1943. Cooperative work employed for Lally Column Company, Cambridge, Mass., as draftsman, computer and checker on airport construction for the Boston District of U.S.E.D.; detailer for Fay, Spofford and Thorndike; surveyor for Turner Construction Company. November, 1943, entered the Naval Service and received commission as Ensign in the Civil Engineering Corps, March 31, 1944. After further training in the United States, was sent overseas with the 124th U. S. Naval Construction Battalion to the Aleutian area. My duties were personnel officer and engineering officer. As engineering officer

duties were to operate the engineering section of Public Works. At present on leave, to be separated from the Navy April 11, 1946. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, E. L. Spencer.*

Rudolph A. Lofgren, Wollaston, Mass. (b. January 18, 1905, Quincy, Mass.) Graduated from Northeastern University in 1927, B.S. degree in Civil Engineering; 1927-1928, University Extension, Advanced Concrete Design; 1928-1929, Boston Architectural Club, Design; 1931-1932, University Extension, Modern Building Construction; 1943-1944, U. S. Navy, Course in Spanish. Experience, 1926-1927, computer, draftsman, instrument man and chief of survey parties for Metropolitan District Commission, Parks Department and Metropolitan District Water Supply Commission; 1928-1935, Construction Manager for W. R. Lofgren, Quincy, Mass., work included design, drafting, estimating and supervision of residential, industrial and commercial building construction; 1935-1943, City of Quincy, Public Works Department, Engineering Department, administrative and construction engineer in charge of design, estimating and general supervision of construction projects including public buildings, alterations, stadiums, parks, roads, waterways, etc; April, 1943—October, 1945, Lt. CEC-USNR Assistant Public Works Officer at two large Naval Air Stations; San Juan, P. R. and Quonset Point, R. I. General Maintenance and Construction Manager with collateral duties of Exec. Officer, Personnel Officer, Design Supt., and Office Manager; December, 1945-March, 1946, Construction Manager and Estimator, H. E. Wile, Bldg., Contractor, Newton, Mass. At present employed by W. R. Lofgren & Sons Bldg. Contractors and Construction Supt. Refers to *C. S. Ell, C. O. Baird, T. G. Giblin, E. A. Gramstorff, G. H. Newcomb.*

Arthur F. McVarish, Somerville, Mass. (b. November 28, 1916, Somerville, Mass.) Graduated from Tufts College, class of 1938, with B.S. degree in Civil Engineering. Experience, employed briefly in City Engineer's office, Somerville, Mass., in 1937; summer of 1937, with B. Perini, on Newburyport Turnpike, in field party; October, 1938, to January, 1940, Junior Engineer, U. S. Geological Survey, Water Resources Branch, Boston, Mass.; January, 1940, to March, 1944, Junior Engineer and Assistant Engineer with U. S. Geological Survey, Atlanta, Georgia; April, 1944, to date, Assistant Engineer, Maintenance Department of Boston Elevated Railway. Refers to *F. C. Bell, H. P. Burden, A. J. Blackburn, F. N. Weaver.*

Franklin P. Parker, Wellesley Hills, Mass. (b. August 13, 1914, Salt Lake City, Utah). Graduated from the Massachusetts Institute of Technology in 1936, with B.S. degree in Architectural Engineering. Experience, July, 1936, to December, 1941, with Charles T. Main, Inc., in the office successively as draftsman, computer, estimator and designer of hydraulic and industrial structures, and intermittently in the field as inspector and resident engineer. The projects on which I worked included earth fill, gravity and concrete arch dams, water conduits, both open channel and pressure tunnel, bridges, mill buildings, shipyard, foundations and miscellaneous valuation and appraisal work. During 1941, was resident engineer at two jobs, a mill building and a shipyard, the construction cost of which exceeded \$8,000,000. Also made several field investigations followed by structural design and report. January, 1942, to October, 1945, served in the Corps of Engineers, Army of U. S., in various capacities. Principal assignments were with the Boston and Manhattan Engineer Districts and the Office of the Theater Engineer,

C-B-I Theater. Positions held were Area Engineer and Assistant Operations Officer. Highest rank Major. At present employed by Charles T. Main, Inc., Boston, Mass. Refers to *F. M. Mahard, L. G. Ropes, B. S. Rose, T. H. Safford, W. F. Uhl.*

Henry G. Seeley, South Boston, Mass. (b. May 26, 1916, Boston, Mass.) Graduated from Northeastern University, June, 1940, with B.S. degree in Civil Engineering. Attended Tufts Engineering College for five months, night school during 1942. Experience, with the New York, New Haven and Hartford Railroad for 10 months, 1939-1940, as transitman, draftsman; with Pascone Brothers, Bridgeport, Conn., three months, June, 1940 to October, 1940, as layout man on Federal Housing Project; with Gibbs and Hill, Inc., Pennsylvania Station, New York, as layout man for 10 months in New Haven, building electrical sub-station; with Jackson & Moreland, 10 months as designer and detailer on foundations for Everett Power Plant; with E. B. Badger & Sons Company, as field engineer in Baton Rouge, La., building Rubber Plant; two years in U. S. Navy, Civil Engineer Corps as Lt. (jg), 1944-1946. Refers to *C. O. Baird, E. A. Gramstorff, P. M. Levenson, D. W. Miles.*

Penneth M. Cline, Newton Centre, Mass. (b. November 12, 1917, Boston, Mass.) Graduated from Northeastern University in 1940, B.S. degree in Civil Engineering. Experience, 1938-1940, H. E. Cline Construction Company, lines and grades, assistant to engineer, building construction; 1940-1942, H. E. Cline Construction Company, field superintendent and engineer, supervised various jobs such as Mercantile Building, New Brunswick, N. J.; Mercantile Building, Troy, N. Y.; Apartment Building (\$1,000,000) Boston, Mass.; Mercantile Building, Boston, Mass.; 1942, Massachusetts In-

stitute of Technology, special Naval Architecture War course; 1942-1946, U. S. Army Corps of Engineers, supervised and assisted in design of runways of various airfields, Page Field, Florida, runway at Sarasota, Florida; traffic control coordinator Ledo-Stillwell Road, Burma (coordinating traffic flow with road construction); construction of Military Bridges, road-building on Ledo-Stillwell Road; Design and construction 500-bed permanent hospital, Burma. At present with H. E. Cline Construction Company, construction superintendent and engineer. Refers to *C. O. Baird, A. E. Everett, E. A. Gramstorff, D. W. Miles, A. E. Sanderson.*

Transfer from Grade of Student

Arthur Hebert, Rhode Island. (b. April 4, 1925, Fall River, Mass.) Graduated from Northeastern University, June, 1945, B. S. degree in Civil Engineering. Cooperative work with U. S. Engineers Department, Bedford Army Airbase. June to July, 1943, as inspector for batching and placement of bituminous, asphalt and concrete and instrument man in survey party; June-September, 1945, with O'Driscoll Construction Corporation in Scotia, New York, as project engineer, charge of line and grade, excavation, equipment,

material handling, testing and time records; September-November, 1945, with John B. Waterman, Tiverton, R. I., on installation of Diesel Marine Power Plant and outfitting and rigging of the Fishing Dragger "Invader". At present serving in the Armed Forces. Refers to *C. O. Baird, E. A. Gramstorff, G. W. Hankinson, E. L. Spencer.*

Gordon H. Searles, Boston, Mass. (b. April 6, 1921, Worcester, Mass.) Graduated from Northeastern University, class of 1945, with B.S. degree in Civil Engineering; Experience, with the U. S. Geological Survey as Junior Hydraulic Engineer doing both stream gaging in the field and working up stream flow records in the office. Refers to *C. O. Baird, E. A. Gramstorff, H. B. Kinnison, E. L. Spencer.*

Roy Woolridge, Wollaston, Mass. (b. May 6, 1925, Dorchester, Mass.) Graduated from Northeastern University, June, 1945, with B.S. degree in Civil Engineering. Cooperative work, June, 1943 to July, 1943, with W. S. Crocker, Civil Engineer, Boston, Mass., as rodman in survey party doing line and grade work. Refers to *C. O. Baird, E. A. Gramstorff, E. L. Spencer, W. Nightingale.*

ANNUAL REPORTS

REPORT OF THE BOARD OF GOVERNMENT FOR YEAR 1945-1946

Boston, Mass., March 20, 1946.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the By-Laws, the Board of Government presents its report for the year ending March 20, 1946.

Sixteen new members, and 7 students have been added during the year, and 3 members, 4 juniors, and 4 students have been reinstated, making a total addition of 34 members.

During the year 10 members have died, 7 have resigned, 7 have been dropped for non-payment of dues, and 1 junior and 1 student have been dropped for failure to transfer, making a total deduction of 26.

The present net membership of the Society consists of 7 honorary members, 617 members, 61 juniors, 15 students, and 4 associates, making a total membership of 704, a net gain for the year of 9.

The honorary membership list is as follows:

Dr. Karl T. Compton, elected, February 17, 1932
Prof. C. Frank Allen, elected, March 16, 1932
Prof. Charles M. Allen, elected, January 14, 1942
Arthur W. Dean, elected, January 14, 1942
Charles R. Gow, elected, January 14, 1942
Arthur T. Safford, elected, January 26, 1943
Charles M. Spofford, elected, December 19, 1945

Deaths

Members:

William F. Covil, March 23, 1945
J. Leslie Woodfall, March 29, 1945
Waldo E. Buck, April, 1945
Louis F. Cutter, June 26, 1945
Carl H. Seils, August 2, 1945
J. Donald Mitsch, January 18, 1946
Joseph R. Hews, January 28, 1946
Ralph Whitman, February 3, 1946
Theodore R. Kendall, February 4, 1946
William P. Morse, February 21, 1946

Remission of Dues

During this year the Board of Government granted a number of members an extension of time for payment of dues. In the case of one member, dues for the year ending March 20, 1946, have been remitted, and in addition those members in the Armed Services, numbering 96.

Exemption of Dues

Seventy-nine members are now exempt from dues in accordance with By-Laws 8, which provide that "a member of any grade who has paid dues for forty

years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues".

Meetings of the Society

Eight regular meetings and an excursion since the Annual Meeting have been held during the year.

The November meeting was the Annual Student Night attended by Student Chapters, American Society of Civil Engineers, at Massachusetts Institute of Technology, Tufts, Harvard, Brown University, Dartmouth, Rhode Island State, Worcester Polytechnic Institute and of Northeastern University Section of the Boston Society of Civil Engineers.

The total attendance at all meetings was 744 persons: the largest attendance was 175 and the smallest 27. Suppers have been a feature at all the meetings and they were well attended, a total of 732 at all dinners.

The papers and addresses given were as follows:

March 21, 1945. Annual Meeting. Address of retiring President, Harry P. Burden, "Education for Civil Engineering", followed by dinner.

April 17, 1945. Joint Meeting. American Society of Civil Engineers, Northeastern Section and Boston Society of Civil Engineers. "The Port of Boston and Its Redevelopment", by the Honorable Jarvis Hunt.

June 6, 1945. "The Engineering Contribution to Victory in Europe", by Waldo G. Bowman, Editor of *Engineering News Record*, N. Y.

September 26, 1945. "Pressure Treated Wood—A Modern Material for Engineering Structures", by Ralph H. Mann, Field Engineer Service Bureau, American Wood Preservers' Association.

October 17, 1945. "The Development of the New York Navy Yard During World War II", by Capt. Mack W. Angas, CEC, USN, Superintending Civil Engineer, Area II.

November 20, 1945. Student Night. Joint Meeting. Boston Society of Civil Engineers, and American Society of Civil Engineers, Northeastern Section and Student Chapters ASCE and Northeastern University Section BSCE. "Influence of Air Power on the Future of America", by Charles Froesch, Chief Engineer, Eastern Airlines, Inc., N. Y.

December 19, 1945. "Fluoride in the Treatment of Water Supplies and its Effect on Dental Health", by Dr. Vlado Getting, Commissioner of Public Health of Massachusetts.

January 23, 1946. "Experiences in Making a River Serve Multiple Users", by Bryant L. Hopkins, Hydraulic Engineer and Manager, Kennebec Water Power Company, Bangs Station, Waterville, Maine. Joint Meeting with the Hydraulics Section, BSCE.

February 20, 1946. "Use of Plastics in Civil Engineering", by E. S. Childs, of the Plastics Division, of Monsanto Chemical Company, Springfield, Mass.

Sections

Twenty-seven meetings were held by the Sections of the Society during the year. These meetings of the Sections offering opportunity for less formal discussion, have continued to demonstrate their value to their members and to the Society. The variety of subjects presented has made an appeal to the members, as indicated by the general attendance at these meetings.

Sanitary Section Meetings. The Sanitary Section has held 5 meetings during the year, with an average attendance of 36. The papers and meetings are listed in the report of the Executive Committee.

Designers Section Meetings. The Designers Section has held 7 meetings during the year, with an average attendance of 45. The papers and meetings during the year are listed in the report of the Executive Committee.

Highway Section Meetings. The Highway Section has held 2 meetings during the year, with an average attendance of 22. The papers and meetings are listed in the reports of the Executive Committee.

Hydraulics Section Meetings. The Hydraulics Section has held 4 meetings during the year, with an average attendance of 46. The papers and meetings are listed in the report of the Executive Committee.

Northeastern University Section Meetings. The Northeastern University Section held 9 meetings during the year, with an average attendance of 10. The meetings held are listed in the report of the Executive Committee.

Journal

The complete report of the Editor of the JOURNAL for the calendar year 1945 will be printed in the April, 1946, JOURNAL.

*Funds of the Society**

Permanent Fund. The Permanent Fund of the Society has a present value of about \$65,618. The Board of Government authorized the use of as much as necessary of the current income of this fund in payment of current expenses.

John R. Freeman Fund. In 1925 the late John R. Freeman, a Past President and Honorary Member of the Society, made a gift to the Society of securities valued at that time at about \$25,000, which was established as the John R. Freeman Fund, the income from which is about \$1160. The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to this Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, reports of which would be presented to the Society. No additional scholarship was authorized during the year.

Edmund K. Turner Fund. In 1916 the Society received 1,105 books from the library of the late Edmund K. Turner, and a bequest of \$1000, "the income of which is to be used for library purposes". The Board voted to use \$35 of the income for the purchase of books, for the library.

Alexis H. French Fund. The Alexis H. French Fund, a bequest amounting to \$1000, was received in 1931, from the late Alexis H. French of Brookline, a former Past President of the Society. The income of this fund is "to be devoted to the library of the Society." The Board voted to use \$35 of the available income for the purchase of books for the library.

Tinkham Memorial Fund. The "Samuel E. Tinkham Fund", established in 1921, at the Massachusetts Institute of Technology by the Society "to assist some worthy student of high standing to continue his studies in Civil Engineer-

*Details regarding the values and income of these funds are given in the Treasurer's report

ing", had a value of \$2415.11 on June 30, 1945. No award was made for year 1945-1946.

Desmond FitzGerald Fund. The Desmond FitzGerald Fund, established as a bequest amounting to \$2000 from the late Desmond FitzGerald, a Past President and Honorary Member of the Society, provided that the income from this fund shall "be used for charitable and educational purposes". The only expenditure from this fund during the year was for one prize awarded at the last annual meeting.

Clemens Herschel Fund. This fund was established in 1931, by a bequest amounting to \$1000 from the late Clemens Herschel, a former Past President and Honorary Member of the Society. The income from this fund is to be used for the presentation of prizes for particularly useful and commendable papers presented at a meeting of the Society. The expenditure made during the year from this fund was for prizes.

Edward A. Howe Fund. This fund, a bequest of \$1000, was received December 2, 1933, from the late Edward A. Howe, a former Past President of the Society. No restrictions were placed upon the use of this money, but the recommendation of the Board of Government is that the Fund be kept intact, and that the income be used for the benefit of the Society or its members. The expenditure made during the year from this fund was for refinishing furniture in the Society Rooms.

Prize Awards

Desmond FitzGerald Medal. The Desmond FitzGerald Medal (bronze) was provided for in 1910 as an endowed prize by the late Desmond FitzGerald, a former Past President and Honorary Member of the Society. The prize is awarded annually to a member who presents an original paper to the Society which is published in the JOURNAL for the current year.

In accordance with the recommendation of the Committee on Awards, the Board of Government voted to award a Desmond FitzGerald Medal to Albert G. H. Dietz, member, for his paper on "Details of Design with Timber Connectors", presented at a meeting of the Designers Section, October 13, 1943, and published in the January, 1945, JOURNAL. This year a suitable certificate was awarded until the medals are again available.

Clemens Herschel Award

The late Clemens Herschel, a former Past President and Honorary Member, made a bequest to the Society which would provide for the presentation of prizes for papers presented at meetings of the Society which have been particularly useful and worthy of grateful acknowledgment. On recommendation of the Committee on Awards, the Board voted to award a Clemens Herschel prize to Prof. Charles O. Baird, Jr., member, for his paper on "Photogrammetry", presented at a Joint Meeting of the Main Society and Highway Section, held on February 28, 1945, and published in the April, 1945, JOURNAL. The prize consisted of the following books:

"Fluid Mechanics for Hydraulic Engineer", by Hunter Rouse

"Mathematical Theory of Probabilities, Application to Frequency Curves and Statistical Method", by Arne Fisher.

"Theoretical Soil Mechanics", by Karl Terzaghi.

Section Prizes

The Board of Government voted on April 12, 1924, to present a prize for a worthy paper given in each section by a member of that section. "This award to consist of books suitably inscribed."

Highway Section Prize. The Board adopted the recommendation of the Highway Section Prize Award Committee and voted that the Highway Section Prize be awarded to Prof. Ernest L. Spencer, member, for his paper on "Aerial Mapping Equipment", presented at a Joint Meeting of the Main Society with the Highway Section, held on February 28, 1945, and published in the April, 1945, JOURNAL. The prize consisted of the following books:

"Geology and Engineering", by Robert F. Legget.

"Theoretical Soil Mechanics", by Karl Terzaghi.

"Construction Planning and Plant", by Ackerman & Locher.

Hydraulics Section Prize. The Board adopted the recommendation of the Hydraulics Section Prize Award Committee and voted that the Hydraulics Section Prize be awarded Posthumously to William F. Covil, member, for his paper on "A Practical Formula for the Flow of Water in Pipes". The prize consisting of the following book, suitably inscribed, was delivered to Mr. Covil's daughter:

"The Lincoln Library of Essential Information."

Meetings

Seven of the regular meetings were held at the Twentieth Century Association, one at Northeastern University. An Inspection Trip to General Edward Lawrence Logan Airport, at East Boston was made on November 17, 1945.

Library

The report of the Committee on Library contains a complete account of the library activities during the past year.

Committees

The usual special committees dealing with the activities and conduct of the Society have included the following: Program, Publication, Library, Hospitality, Relations of Sections to Main Society, Welfare, Investment, Subsoils of Boston, John R. Freeman Fund, and the committees on the various Society Awards.

The Society has cooperated with the Engineering Societies of New England, and members of the Society have served on Engineering Societies Council and Committees.

Your Board, in conclusion, wishes to express its appreciation of the excellent work done by the officers of the Sections and by the Committees of the Society.

CARROLL A. FARWELL, *President*

REPORT OF THE TREASURER

Boston, Mass., March 20, 1946.

To the Boston Society of Civil Engineers:

The financial standing of the Society on March 8, 1946, at the end of the accounting period, is shown in the following tables:

Table 1. Distribution of Funds—Receipts and Expenditures.

Table 2. Record of Investments.

The receipts from dues during this year amounted to \$4444.38 compared with \$4317.00 paid in as dues during the previous year. These receipts were \$149.00 less than the average amount received from this source during the past

five years. Dues of members in the Armed Forces, to the extent of \$570 were remitted during the year. The payment of dues by the active members has been very satisfactory.

The income to the Current Fund has again been insufficient to meet current expenses and a transfer of \$836.09 from the income of the Permanent Fund to the Current Fund has been necessary to meet this deficit. This transfer amounts to 32% of the income to the Permanent Fund compared to a similar transfer amounting to 60% for the previous year.

The expenses of the Society have run somewhat lower than the budget estimated for the year and somewhat lower than the expenses during the preceding year. The general price rise has continued and is reflected in the cost of certain phases of the activities of the Society. However, the expenses incurred by the various Sections for their meetings have been less than in previous years in spite of an active program.

The amounts transferred from the Permanent Fund to the Current Fund during the last five years are shown in the following:

	1941-42	1942-43	1943-44	1944-45	1945-46
Receipts to Current Fund					
Dues	\$4876	\$4653	\$4676	\$4317	\$4444
Other than dues	2860	2180	3161	3518	3216
Total Receipts to Current Fund	\$7736	\$6833	\$7837	\$7835	\$7660
Current Fund Expenditure	8738	8243	9246	9239	8496
Deficit: Transferred from Permanent Fund	\$1002	\$1410	\$1409	\$1404	\$836

The records of the Current Income and Current Expenditures are kept separate from those applicable to other accounts. The total of income and profits from all sources during the past year amounted to \$11,855.68 against total expenditures and losses of \$8,701.10, making a net increase in assets of \$3,154.58.

The holdings of the Society in Cooperative Bank Shares were continued throughout the year. The running shares were maintained and payments were made monthly, thereby increasing the value of all our holdings from \$11,535.19 on March 5, 1945, to \$12,068.89 on March 8, 1946.

Refunding of bond issues were numerous during the year and the following bonds held by the Society were called:

1000 Standard Oil of New Jersey	2¾%	July 1, 1953
2000 Texas Electric Service Co.	5%	July 1, 1960
2000 Union Pacific R. R. Co.	3½%	June 1, 1980

American Telephone and Telegraph Bonds in the amount of \$600 were converted into six shares of Capital Stock of the same company at a cost of \$240 in addition to the bonds.

Ten shares of Minnesota Power and Light Co., 7% preferred stock were called for exchange for which the Society received 10 shares of 5% preferred stock and \$98.

Twenty shares of U. S. Smelting, Refining and Mining Company were sold.

The following securities were purchased for the Society during the year:

20 Shares of Radio Corporation of America, 1st Pfd.
\$4000, Southern Pacific Oregon Lines, 4½%, March 1, 1977.

A dividend check from the Tampa Electric Company, amounting to \$12.00, and one from the Bankers Trust Company amounting to \$12.60, which should have been received during the past fiscal year were presumably lost in the mail. The checks replacing these were received after the closing of the books. These dividends are not included in the income reported in Table 1.

The Boston Safe Deposit and Trust Company has continued to act as Investment Counsel for the Society throughout the year and they were consulted in connection with all purchases and sales of securities.

The total book value of all securities, plus cash on hand now stands at \$103,335.88, an increase of \$3,154.58 in assets during the year.

The following table shows the comparative book values of the two principal funds at the close of the last five years and the ratio of market value to book value.

	Mar. 6, 1942	Mar. 6, 1943	Mar. 6, 1944	Mar. 8, 1945	Mar. 8, 1946
Permanent Fund	\$61,080	\$62,283	\$62,546	\$63,690	\$65,618
John R. Freeman Fund	26,528	26,862	27,470	28,497	29,654
Market Value in percent of Book Value	83.44%	88.57%	96.47%	101.7%	114%

The growth of the Permanent Fund is affected not only by the percentage of return on investments, but also by the amount it has been necessary to transfer from the income of this fund, in order to meet current expenses. The value of the Freeman Fund depends largely upon the expenditures made from the fund during the year and as no expenditures were made during the past year the only charge to the fund has been the allocation of book loss incurred through the sale of depreciated securities, amounting to \$3.25 as shown in Table 1.

The following table shows for the past five years the book value of securities and bank deposits and the total value of all holdings, not including the value of the library and physical property.

	Mar. 6, 1942	Mar. 6, 1943	Mar. 6, 1944	Mar. 8, 1945	Mar. 8, 1946
Bonds	\$31,610.49	\$38,670.49	\$38,763.93	\$35,816.10	\$34,318.15
Cooperative					
Banks	19,490.68	12,392.68	10,942.02	11,535.19	12,068.89
Stocks	43,067.17	43,067.17	45,186.63	50,708.44	51,809.15
Cash	365.94	2,031.39	2,981.57	2,121.57	3,639.69
	\$95,434.28	\$97,061.73	\$97,874.15	\$100,181.30	\$101,835.88

The Treasurer's cash balance of \$3,639.69 included \$30.00, withholding taxes of the office secretary for the months of January and February, 1946, which is payable to the Collector of Internal Revenue in April, 1946. The Secretary's "change fund", \$30, however, is not included in the cash balance shown above.

Respectfully submitted,

CHESTER J. GINDER, *Treasurer*

TABLE 1—DISTRIBUTION OF FUNDS—RECEIPTS AND EXPENDITURES

	Book Value March 8, 1945	Interest and Dividends (Cash)	Net Profit or Loss at Sale or Maturity + —	Transfer Purchased + Sold —	Book Value March 8, 1946	
Bonds	\$35,816.10	\$1,030.01	\$60.00	\$4,191.30	\$34,318.15	
Cooperative Banks	11,535.19	68.75	173.70	360.00	12,068.89	
Stocks	50,708.44	2,365.97	259.17	2,563.75	51,809.15	
Cash available for Investment	621.57			3,018.12	3,639.69	
Total (except Current Fund)	\$98,681.30	\$3,464.73	\$233.70	\$10,133.17	\$101,835.88	
	Book Value March 8, 1945	Allocation of the above Income and Profit 40%		Misc. Receipts	Misc. Expenditures	Book Value March 8, 1946
Permanent Fund	\$63,690.42	\$2,593.02	\$7.26			\$65,618.09
John R. Freeman Fund	28,497.41	1,160.21	3.25	\$178.00	\$836.09	29,654.37
Edmund K. Turner Fund	973.22	39.62	.11		35.00	977.73
Desmond FitzGerald Fund	1,943.39	79.12	.22		12.00	2,010.29
Alexis H. French Fund	1,035.01	42.14	.12		35.20	1,041.83
Clemens Herschel Fund	1,252.01	50.97	.14		59.98	1,242.86
Edward A. Howe Fund	1,289.84	52.52	.15		51.50	1,290.71
Current Fund	\$98,681.30	\$4,017.60	\$11.25	\$178.00	*\$1,029.77	\$101,835.88
	1,500.00			*8,496.17	8,496.17	1,500.00
Total	\$100,181.30	\$4,017.60	\$11.25	\$8,674.17	\$9,525.94	\$103,335.88

^aSecretary's change fund of \$30.00 should be added to show total assets.

*Includes transfer of \$836.09 from income of the Permanent Fund to the Current Fund.

TABLE 2—RECORD OF INVESTMENTS

	Date of Maturity or Classification	Fixed or Current Interest Rate	During the Year March 8, 1945 to March 8, 1946				March 8, 1946	
			Interest Received	Additional Amount Invested	Sold or Cost	Matured Profit + (or loss -)	Par Value	Book Value
BONDS								
American Telephone & Telegraph Co.	Sept. 1, 1956	3%	\$ 13.65	....	603.00	....	....	....
	July 2, 1949	4%	153.17	....	....	....	\$5,000.00	\$5,342.50
Canadian Pacific R. R.								
Penn. Central Light & Power Co.	Nov. 1, 1977	4½%	45.00	....	....	....	1,000.00	1,052.89
The Pennsylvania Rail- road Co.	June 1, 1965	4½%	45.00	....	....	....	1,000.00	1,017.74
Puget Sound Power & Light Co.	Dec. 1, 1972	4¼%	42.50	....	....	....	1,000.00	1,058.44
Standard Oil Co. of New Jersey	July 1, 1953	2¾%	18.33	....	1,021.25	6.25—	....	....
Southern Pacific Oregon	Mar. 1, 1977	4½%	88.75	4,191.30	....	....	4,000.00	4,191.30
Texas Electric Service Company	July 1, 1960	5%	43.61	....	2,000.00	60.00 +	....	....
The Toledo Edison Co.	July 1, 1968	3½%	70.00	....	..	....	2,000.00	2,092.50
Union Pacific R.R. Co.	June 1, 1980	3½%	70.00	....	2,125.00	5.00—	....	....
Western Maryland R. R. Co.	Oct. 1, 1952	4%	40.00	....	....	....	1,000.00	982.78
United States Savings Bonds, Series D	Jan. 1, 1950	....	60.00	....	....	....	3,000.00	2,580.00
United States Savings Bonds, Series G	June 1, 1953	2½%	200.00	....	....	....	8,000.00	8,000.00
United States Bonds, Series G	July 1, 1954	2½%	175.00	....	....	....	7,000.00	7,000.00
United States Savings Bonds, Series G	Nov. 1, 1956	2½%	25.00	....	....	....	1,000.00	1,000.00
TOTALS			\$1,090.01	\$4,191.30	\$5,749.25	48.75 +	\$34,000.00	\$34,318.15
								\$35,525.00

TABLE 2—RECORD OF INVESTMENTS—Continued

Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 8, 1945 to March 8, 1946			Number of Shares	March 8, 1946	
		Dividends Received	Additional Amount Invested	Sold or Matured Amount Received (or Loss—)		Book Value	Market Value
Co-OPERATIVE BANKS							
Codman Co-Operative Bank							
Suffolk Co-Operative Loan Assoc.							
Suffolk Co-Operative Federal Savings & Loan Assoc.							
Series 134							
TOTALS							
Matured Shares	3 $\frac{1}{4}$ %	\$48.75	....	....	10	\$2,000.00	\$2,000.00
Matured Shares	2%	20.00	....	....	5	1,000.00	1,000.00
Series 134	....	173.70	\$360.00	....	30	9,068.89	9,068.89
TOTALS		\$242.45	\$360.00	....		\$12,068.89	\$12,068.89

TABLE 2—RECORD OF INVESTMENTS—Continued

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 8, 1945 to March 8, 1946				Number of Shares	March 8, 1946		
			Dividends Received	Additional Amount Invested	Sold or Matured			Book Value	Market Value	
					Cost	(or Loss —) Profit +				
STOCKS										
American Tel. & Tel. Co.	Common	\$9.00	\$444.90	843.00	....	....	52	\$6,189.04	\$9,925.24	
Bankers Trust Co., N. Y.	Common	1.40	37.80*	....	....	....	36	1,590.00	1,746.00	
Central Hanover Bank & Trust Co., N. Y.	Common	4.00	120.00	....	....	....	30	3,210.00	3,480.00	
Commonwealth & Southern Corp.	Cum. Pfd.	5.00	42.00	....	....	....	8	....	1,008.00	
Commonwealth & Southern Corp.	Common							25	1,019.89	96.88
Commonwealth & Southern Corp.	Opt. Warrants	....	....	....	....	....	12	....	3.75	
Consolidated Natural Gas Company	Capital	2.00	4.00	....	....	....	2	49.87	92.50	
Consolidated Edison (Gas) Co. of N. Y.	Common	1.60	32.00	....	....	....	20	1,906.50	672.50	
Continental Insurance Co.	Capital	2.00	50.00	....	....	....	25	1,206.44	1,412.50	
Erie Railway 5% Pref.	Pref.	5.00	75.00	....	....	....	15	1,133.05	1,245.00	
General Electric Co. of N. Y.	Common	1.60	80.00	....	....	....	50	2,341.47	2,387.50	
Great Northern Railway	Pref.	3.00	45.00	....	....	....	15	778.67	866.25	
Hartford Fire Insurance Co.	Common	2.50	25.00	....	....	....	10	761.25	1,287.50	
Minnesota Power & Light Co., Minn.	Pref.	5.00	60.00	....	98.00	....	10	882.00	1,062.50	
National Dairy Products Corp.	Common	1.40	70.00	....	....	....	50	1,154.74	1,981.25	
National Fire Insurance Co. of Hartford	Common	2.00	40.00	....	....	....	20	1,240.00	1,390.00	
New England Power Assoc.	Pref.	4.00	80.00	....	....	....	20	1,815.00	1,740.00	
North American Trust Shares	July 15, 1955	13.2¢	198.00	....	....	....	1500	5,342.00	5,640.00	

TABLE 2—RECORD OF INVESTMENTS—Continued

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 8, 1945 to March 8, 1946				Number of Shares	March 8, 1946		
			Dividends Received	Additional Amount Invested	Sold or Matured Profit + Cost (or Loss)			Book Value	Market Value	
STOCKS										
Pacific Gas & Elec. Co.	Cum. 1st Pfd.	\$1.50	\$90.00	....	....	....	60	....	\$3,500.00	
Pacific Gas & Elec. Co.	Cum. 1st Pfd.	1.37	27.52	....	....	....	20	\$1,922.02		
Pacific Gas & Elec. Co.	Common	2.00	128.00	....	....	....	64	1,808.79	2,832.00	
Radio Corp. of America	1st Pfd.	1.75	35.00	1,720.75	....	....	20	1,720.75	1,820.00	
Southern California Edison Co. Ltd.	Cum. Orig. Pfd.	1.50	60.00	....	....	....	40	1,161.27	1,240.00	
Southern California Edison	Common	1.50	30.00	....	....	....	20	539.75	730.00	
Southern Railway	Pref.	5.00	56.25	....	....	....	15	1,136.80	1,260.00	
Standard Oil Co. of N. J.	Capital	2.50	50.00	....	....	....	20	1,011.10	1,315.00	
Tampa Electric Co.	Common	1.60	36.00*	....	....	....	30	1,151.25	1,005.00	
Timken Roller Bearing Co.	Common	2.00	30.00	....	....	....	15	1,018.97	870.00	
Trimount Dredging Co.	Pref.	....	....	....	....	....	2	....	....	
Union Carbide & Carbon	Capital	3.00	90.00	....	....	....	30	2,407.79	3,127.50	
Union Pacific Railroad	Common	6.00	132.00	....	....	....	22	2,473.29	3,305.50	
U. S. Smelting Refining & Mining Co.	Pref.	3.50	17.50	....	1,365.04	259.17 +	20	....	....	
United States Trust Co. of Boston	Conv. Pref.	.80	180.00	....	....	....	225	4,837.50	5,006.25	
TOTALS										
			\$2,365.97	\$2,563.75	\$1,463.04	259.17 +		\$51,809.15	\$62,048.62	
*Banker's Trust Co., dividend of \$12.00 and Tampa Electric Co., dividend of \$12.00 were in transit at the close of period and received after books were closed.										

*Banker's Trust Co., dividend of \$12.00 and Tampa Electric Co., dividend of \$12.00 were in transit at the close of period and received after books were closed.

REPORT OF THE SECRETARY

Boston, Mass., March 8, 1946.

To the Boston Society of Civil Engineers:

The following is a statement of cash received by the Secretary and of the expenditures approved by the President, in accordance with the Budget adopted by the Board of Government.

FOR THE YEAR ENDING MARCH 20, 1946
CURRENT FUND ACCOUNT

	Account Number	Expenditures	Receipts
<i>Office</i>			
Secretary, salary and expense	(1)	\$240.00	
Stationery, printing and postage	(2)	279.80	
Incidentals and Petty Cash	(3)	109.10	
Insurance and Treasurer's Bond	(4)	48.10	
Safety Deposit Box	(5)	12.00	
Quarters, rent, light, telephone	(7)	1,757.65	\$600.00
Office—clerical	(8)	1,565.00	
Auditors for 1945 accounts and Investment Service	(9)	250.00	
<i>Meetings</i>			
Rent of Halls	(11)	178.00	
Stationery, printing	(12)	28.85	
Hospitality	(13)	1,015.34	909.70
Stereopticon and reporting	(14, 15)	5.00	
Annual Meeting (March 1945)	(16)	94.60	
<i>Sections</i>			
Sanitary Section	(21)	16.00	
Designers Section	(22)	8.00	
Highway Section	(23)	0.00	
Northeastern Univ. Section	(24)	15.00	
Hydraulics Section	(25)	8.00	
<i>Journal</i>			
Editor's salary and expense	(31)	308.00	
Printing and postage	(32)	1,723.51	
Reprints	(33)	....	
Advertising	(34)		887.00
Sale of Journals and reprints	(35, 36)		747.10
<i>Library</i>			
Books and expense	(41)	66.40	
Periodicals	(43)	90.42	
Binding	(44)	53.10	
Fines on Overdue Books and Misc.	(54, 45)	8.00	11.00
Dues to Eng. Societies of New England	(59)	551.23	
Dues from BSCE Members	(70)		4,444.38
Badges for Members	(51)	43.50	43.50

	Account Number	Expenditures	Receipts
Binding Journals for members	(52)	19.60	17.40
Bank Charges	(53)	1.97	
Transfer Income Permanent Fund to Current Fund			836.09
<i>Entrance Fees to Permanent Fund</i>	\$178.00	\$8,496.17	\$8,496.17

16 new members: 7 students; 4 juniors transferred to members; 7 students transferred to juniors.

The above receipts have been paid to the Treasurer, whose receipt the Secretary holds. The Secretary holds cash amounting to \$30 to be used as a fixed fund or cash on hand for making change at buffet suppers.

Respectfully submitted,

EVERETT N. HUTCHINS, *Secretary*

REPORT OF THE AUDITING COMMITTEE

Boston, Mass., March 20, 1946.

To the Boston Society of Civil Engineers:

We have reviewed the records and accounts of the Secretary and Treasurer of the Boston Society of Civil Engineers and the report of William J. Hyde, Certified Public Accountant, who has examined said records and accounts and we have examined the securities enumerated by the Treasurer.

We have accepted and present herewith with our approval the signed report of the Accountant.

ALBERT E. KLEINERT

FRANCIS H. KINGSBURY

*Auditing Committee of the Directors of
the Boston Society of Civil Engineers*

March 18, 1946.

MR. ALBERT E. KLEINERT
*Chairman of the Auditing Committee
Boston Society of Civil Engineers,*

DEAR SIR:

In accordance with instructions, I have completed the annual audit of the financial records of the Society for the fiscal year ended March 8, 1946 and report as follows.

Securities held by the Society as of March 8, 1946 were examined and found complete. All coupons for interest due were collected. Two dividend checks totaling \$24.60 were lost in the mail and replacement checks were not received in time to be included in the year's receipts. The remaining dividends earned were correctly accounted for.

All changes in securities owned were found recorded in the accounts. All receipts of income including entrance fees, as recorded in the Secretary's records, also interest and dividends were found correctly recorded in the Treasurer's accounts and deposited in the bank.

Cooperative Bank earnings were verified and found correct.

All disbursements were in settlement of vouchers duly approved by the President and Secretary and were substantiated by examination of checks paid by the bank.

Withheld taxes for January and February amount to \$30. and will be turned over to the Collector of Internal Revenue in April. The Secretary's change fund is \$30 and, as has been the custom in the past, is not included in the assets reported by the Treasurer. Thus the tax liability is just offset by the change fund this year.

A verified copy of the Treasurer's report is attached hereto and summaries of his ledger accounts are shown in detail.

I found the records of the Treasurer for the fiscal year ending March 8, 1946, in excellent condition, any necessary changes have been made and the accounts are correct.

Respectfully submitted,

WILLIAM J. HYDE, *Certified Public Accountant*

REPORT OF THE EDITOR

Boston, Mass., January 19, 1946.

*To the Board of Government,
Boston Society of Civil Engineers.*

The JOURNAL for the calendar year 1945 (Volume XXXII) was issued quarterly, in the months of January, April, July and October, as authorized by the Board of Government on December 20, 1935.

During the year 1945 there have been published seven papers presented at meetings of the Society and Sections, and one other article. The Table of Contents and Index for the year are included in the October, 1945, issue.

The four issues of the JOURNAL contained 195 pages of papers and discussions, 5 pages of Index, and 36 pages of advertising, a total of 236 pages. An average of 1025 copies per issue were printed. The net cost was \$319.60 as compared with \$528.87 for the preceding year.

The cost of printing the JOURNAL was as follows:

Expenditures

Composition and printing	\$1,194.47
Cuts	540.80
Wrapping, mailing and postage	60.42
Editing	300.00
Copyright	8.00

\$2,103.69

Receipts

Receipts from sale of JOURNALS and reprints	\$ 785.09
Receipts from Advertising	999.00

\$1,784.09

Net cost of JOURNAL to be paid from Current Fund

\$319.60

Respectfully submitted,

EVERETT N. HUTCHINS, *Editor*

REPORT OF THE COMMITTEE ON WELFARE

To the Boston Society of Civil Engineers:

During the past year the Welfare Committee has stood ready to function if lack of engineering employment should indicate it to be necessary. However, local engineering employment has been in a healthy state, with supply and demand tending to move wages upward.

No matters pertaining to the welfare of members of the Society have come to the Committee's attention and in consequence no meetings of the Committee have been held during the year.

Local employment opportunities in the engineering and architectural fields are now handled by Employment Service for Engineers and Architects which is operated by Emergency Planning and Research Bureau, Inc., located at 101 Tremont Street, Boston.

Respectfully submitted,

R. W. HORNE, *Chairman*

REPORT OF THE HOSPITALITY COMMITTEE

Boston, March 20, 1946.

To the Boston Society of Civil Engineers:

The Hospitality Committee submits the following report for the year 1945-46.

Seven regular meetings, a Student Night meeting and an Annual Dinner were held during the year. All meetings except that for Student Night were at the 20th Century Club.

The attendance at the Annual Dinner in March was 175 or 57 less than at the previous Annual Meeting. The Student Night meeting was held at Northeastern University and the attendance was 155 or 5 less than were present at the previous year's meeting.

The total attendance at the meetings was 744, an average of 93 persons per meeting.

The summary of meetings and attendance follows:

Date	Speaker	Place	Attendance	
			Dinner	— Meeting
3-21-45	Harry P. Burden	20th Century Assoc.	175	175
4-17-45	Hon. Jarvis Hunt	20th Century Assoc.	60	60
5-16-45	Maj. W. G. Bowman	20th Century Assoc.	115	115
9-26-45	Ralph H. Mann	20th Century Assoc.	63	75
10-17-45	Capt. M. W. Angas	20th Century Assoc.	59	59
11-20-45	Charles E. Froesch	Northeastern University	155	155
12-19-45	Dr. Vlado Getting	20th Century Assoc.	28	28
1-23-46	Bryant L. Hopkins	20th Century Assoc.	50	50
2-20-46	Elliot S. Childs	20th Century Assoc.	27	27
			732	744

Respectfully submitted,

JOHN H. HARDING, *Chairman*

REPORT OF THE LIBRARY COMMITTEE

Boston, Mass., March 20, 1946.

To the Boston Society of Civil Engineers:

The following books were purchased during the year and are now available on the shelves:

Stresses in Framed Structures, 2nd Ed., by George A. Hool and W. E. Kinne.

Reinforced Concrete and Masonry Structures, 2nd Ed., by George A. Hool and W. S. Kinne.

Movable and Long-Span Steel Bridges, 2nd Ed., by George A. Hool and W. S. Kinne.

Foundations, Abutments and Footings, 2nd Ed., by George A. Hool and W. S. Kinne.

Structural Members and Connections, 2nd Ed., by George A. Hool and W. S. Kinne.

Steel and Timber Structures, 2nd Ed., by George A. Hool and W. S. Kinne.

Design Data Book for Civil Engineers, by Elwyn E. Seelye.

Mechanical and Electrical Equipment for Building, 2nd Ed., by Charles Merrick Gay and Charles De Van Fawcett.

Materials and Methods of Architectural Construction, 2nd Ed., by Charles M. Gay and Harry Parker.

Formulas for Stress and Strain, 2nd Ed., by Raymond J. Rourk.

A New Manual of Logarithms. Revised Ed., by Dr. Bruhns.

Piping Handbook, 4th Ed., by Sabin Crocker.

Airplane Structures, 3rd Ed., by Alfred F. Niles and Joseph S. Newell, Vol. I and II.

Reinforced Concrete Design, 2nd Ed., by Hale Sutherland and Raymond C. Reese.

A point was made this year of purchasing the volumes earlier than in other years.

Our new librarian, Mr. Thomas C. Coleman, has taken hold of his job well. Progress is being made on the disposal of certain old material of little value, which is available elsewhere in other libraries in the city. This material has been listed and is being offered first to any agencies or institutions interested, and second, to our members.

In the selection of this material we gratefully acknowledge the assistance of Mr. Athole B. Edwards, Past President.

The number of books loaned during the year was 95. The amount collected in fines was \$3.00.

Respectfully submitted,

ALLEN J. BURDOIN, *Chairman*

COMMITTEE ON RELATION OF SECTIONS TO MAIN SOCIETY

Boston, Mass., March 20, 1946.

To the Boston Society of Civil Engineers:

There has been very little activity on the part of the Committee on Relations of Sections to the Main Society during the past year. On several occasions the Chairman has discussed informally with other members of the Committee and

with the President of the Society the need for any action by the Committee. In each case, it has been decided that no action was required and there have not been any formal meetings of the Committee during the year.

Respectfully submitted,

FRANK L. LINCOLN, *Chairman*

REPORT OF THE COMMITTEE ON SUBSOILS OF BOSTON

Boston, Mass., March 16, 1946.

To the Boston Society of Civil Engineers:

The subsoils committee has no activities to report for the year just completed. The committee, however, plans a more active continuation of its program of collecting borings records and other subsurface data in the Boston area as soon as conditions permit.

Respectfully submitted,

DONALD W. TAYLOR, *Chairman*

REPORT OF COMMITTEE ON JOHN R. FREEMAN FUND

Boston, Mass., March 20, 1946.

To the Boston Society of Civil Engineers:

It is now four years since any distribution of the John R. Freeman Fund has been made. The last use of the income was a contribution of \$800 each to Harvard University, the Massachusetts Institute of Technology and the Worcester Polytechnic Institute, to assist in hydraulic research. None of these institutions were able to use the money at the time. Harvard returned it, and the other two were persuaded to hold it for future use, but have not yet, as far as the Committee knows, made any use of it.

During these years of inactivity the income of the fund has accumulated and now amounts to \$4,654.00.

The Committee has decided that it would be advisable this year to start again some form of scholarship awards. No definite plans have yet been made but it is probable that this will take the form of a scholarship for a young engineer for travel to laboratories and centers of hydraulic research in this country or for hydraulic research. The Committee will welcome any suggestions for plans for such a scholarship this year. These should be submitted in writing to the Committee before April 15.

For the John R. Freeman Fund Committee,

HOWARD M. TURNER, *Chairman*

REPORT OF THE EXECUTIVE COMMITTEE OF THE SANITARY SECTION

Boston, Mass., March 6, 1946.

To the Sanitary Section, Boston Society of Civil Engineers:

During the past year five meetings have been held as follows:

March 7, 1945.—Annual Meeting and election of officers. Major Walter E. Merrill presented a paper entitled "Water Supply and Sewage Disposal at Uncle Sam's Army Bases in the Caribbean Area". Attendance, 38.

October 3, 1945.—Mr. Allen J. Burdoin presented a paper entitled "Gas Engine Power for Sewage Treatment Plants". Attendance, 29.

November 7, 1945.—Joint Meeting of the Hydraulics Section and the Sanitary Section. Mr. R. M. Leggette spoke on "Artificial Recharge of Ground Water". Attendance, 36.

December 5, 1945.—Prof. Gordon M. Fair presented a paper entitled "New Enemies and Old Friends in Sanitary Engineering". Attendance, 48.

December 19, 1945.—Joint Meeting of the Boston Society of Civil Engineers and the Sanitary Section. Dr. Vlado A. Getting spoke on "Fluoride in the Treatment of Water Supplies and Its Effect on Dental Health". Attendance, 28.

The average attendance was 36.

Four meetings of the Executive Committee have been held during the year.

Respectfully submitted,

GEORGE C. HOUSER, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE DESIGNERS SECTION

Boston, Mass., March 15, 1946.

To the Designers Section, Boston Society of Civil Engineers:

During the past year the following meetings were held.

March 14, 1945.—Annual Meeting and election of officers. Mr. James F. Brittain presented a paper entitled "Experiences in the Construction of Steel Floating Drydocks". Attendance, 43.

April 11, 1945.—Joint Meeting of the Designers Section with the Highway Section and Northeastern University Section. Mr. William L. Shannon presented a paper entitled "Frost Investigations at Dow Field, Bangor, Maine". Attendance, 60.

October 17, 1945.—Joint Meeting of the Designers Section with the Highway Society. Capt. Mack W. Angas presented a paper entitled "The Development of the New York Navy Yard During World War II". Attendance, 60.

November 14, 1945.—Prof. Joseph S. Newell presented a paper entitled "Some Problems in the Analysis of Aircraft Structures". Attendance, 19.

December 12, 1945.—Mr. Oscar S. Bray presented a paper entitled "Design and Construction of Mystic River Tunnel". Attendance, 54.

January 9, 1946.—Mr. Herman G. Protze presented a paper entitled "Investigation of Causes of Defective Concrete—Their Prevention, Correction and Evaluation". Attendance, 56.

February 13, 1946.—Mr. Henry Brask presented a paper entitled "Unloading Towers for Handling Bulk Materials". Attendance, 22.

The average attendance was 45.

Total attendance for the year was 314.

Respectfully submitted,

HENRY O. WYNER, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE HIGHWAY SECTION

Boston, Mass., March 8, 1946.

To the Highway Section, Boston Society of Civil Engineers:

January 30, 1946.—Mr. Ralph Hansen of the United States Engineering Office, addressed the group on "The Design of Flexible Pavements". Attendance, 21.

February 27, 1946.—Annual Meeting and election of officers. Mr. Philip Kitfield, Assistant Project Engineer, Massachusetts Department of Public Works, spoke on "Massachusetts Department of Public Works Solution to the Traffic Problems in Boston". Attendance, 23.

The total attendance at the meetings was 44.

Respectfully submitted,

GEORGE W. HANKINSON, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE HYDRAULICS SECTION

Boston, Mass., March 8, 1946.

To the Hydraulics Section, Boston Society of Civil Engineers:

The following meetings were held during the past year:

May 2, 1945.—Mr. H. B. Kinnison presented a paper entitled "Flood Formulas". Attendance, 40.

November 7, 1945.—Mr. R. M. Leggette presented a paper entitled "Artificial Recharge of Ground Water". Attendance, 37.

January 23, 1946.—Joint Meeting with Main Society. Mr. B. L. Hopkins presented a paper entitled "Making A River Serve Multiple Users". Attendance, 68.

February 6, 1946.—Mr. M. H. Mellish presented a paper entitled "Hydraulic Features of a Flood Control Project". Attendance, 38.

The total attendance was 183.

The average attendance was 46.

Respectfully submitted,

JOHN G. W. THOMAS, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE NORTHEASTERN UNIVERSITY SECTION

Boston, Mass., March 6, 1946.

To the Northeastern University Section of the Boston Society of Civil Engineers:

The following meetings were held during the past year:—

March 20, 1945.—Mr. Louis H. Berger of the C. L. Berger Company spoke on "Education and Engineers". Attendance, 11.

April 3, 1945.—Field trip to the Squantum Naval Air Station. Attendance, 6.

April 11, 1945.—A Joint Meeting with the Designers Section and the Highway Section of the BSCE. Mr. William L. Shannon of the U. S. Engineer Office spoke on "Frost Investigation at Dow Field, Bangor, Maine". Attendance, 60.

May 17, 1945.—Business meeting and election of new officers. Attendance, 9.

October 1, 1945.—A field trip to the Logan International Airport at East Boston. Students from Tufts College were also present. Attendance, 35.

October 20, 1945.—Professor Charles O. Baird, faculty adviser to the chapter, spoke on obtaining and using data. Attendance, 12.

November 20, 1945.—Annual Student Night was held at Northeastern University. Mr. Charles French spoke on "Air Power". One hundred seventy-five members and guests from New England Engineering Schools were present.

January, 1946.—Joint meeting with Engineering Societies of Northeastern University. Dean William T. Alexander spoke of his experiences in the South Seas. Attendance, 125.

The average attendance of Section members at the meetings was 10, which was nearly one hundred per cent of the Chapter at that time.

Respectfully submitted,

FRANCIS J. MASTROPIERI, *Chairman*

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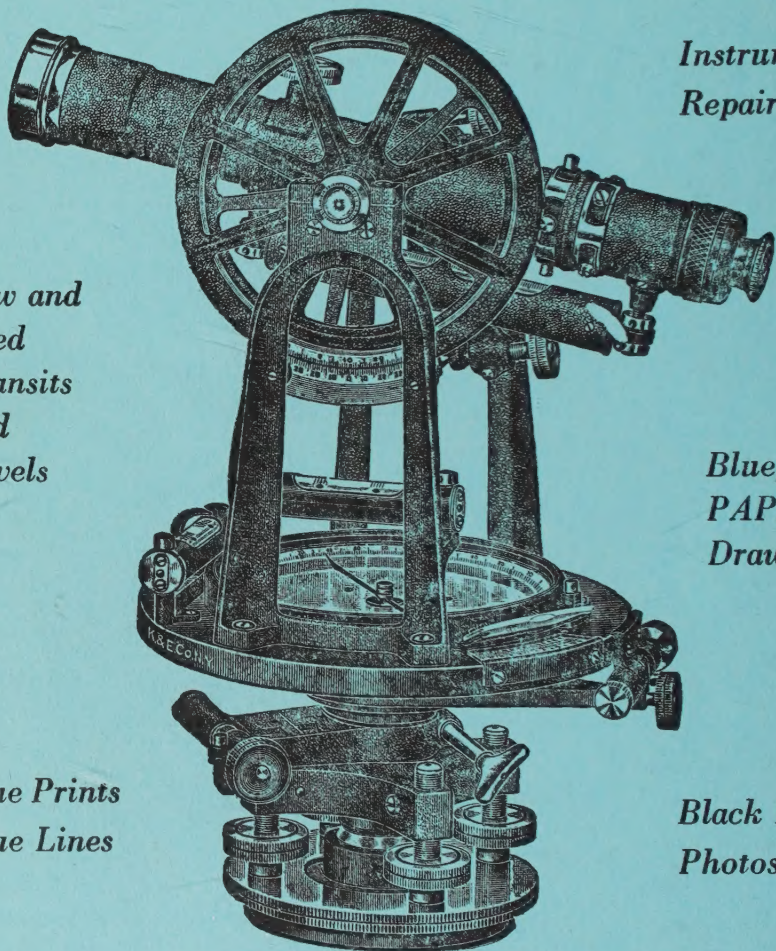
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